MEMORY, EMOTION AND GRIEF:
INVESTIGATING PROCESSES AND A CLINICAL APPLICATION

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“Let go the clinging, yearning and attaching,

Take back home the nature of mind,

May all beings being enlightened,

May all beings purifying negative karma and suffering,

May all beings being peaceful and joyful.”

----- Sogyal Rinpochel, “*The Tibetan Book of Living and Dying*”

ABSTRACT

Multiple disciplines in psychology endeavor to clarify the neural and psychological mechanisms regarding how emotion interacts with memory process, in an attempt to explain emotional influences on learning performance and clinical psychopathology. This thesis proposed a process-oriented perspective on emotion-memory interaction, in which the competitive processes between bottom-up saliency (i.e. extrinsic properties of the stimuli such as physical differences and emotional valence) and top-down modulation (i.e. extra-retinal effects from intrinsic expectations, knowledge and goals) drive psychophysiological arousal (e.g. the selectivity of attention and increased autonomic nervous system activities) to modulate memory processing. The cumulative PhD thesis applied this theoretical perspective to investigate neural process during memory formation and clinical manifestations during memory retrieval.

The first study in neuroscience aimed identify the role of bottom-up and top-down neural mechanisms supporting memory formation of emotional faces. The bottom-up process assumes that emotion works simultaneously with the perception that further contributes to the memory formation. Top-down modulation emphasizes the primary role of prefrontal cortex on the emotional processing. The findings revealed that bottom-up neural mechanism was more dominated and operated through two pathways to the orbitofrontal cortex: the connection from the inferior occipital gyrus correlated with memory performance, independently of valence; whereas the connection from the superior parietal lobule was associated with response bias for negative valence.

In a clinical application, the Study 2 and Study 3 adopted the process-oriented perspective to explore the disruptions in autobiographical remembering as a core psychopathological function of prolonged grief (i.e. a clinical emotional state following bereavement). The bottom-up saliency manifested in the pathologically cognitive process of “preoccupation of loss-related memories”: bereaved persons exhibited a preferential access to loss-related memories in response to negative emotion cues, and tended to use loss-related memories as a reference event for one’s self (i.e. self-defining memories). Meanwhile, as a competitive process, the top-down modulation was supported by the maladaptive mechanisms of “functional avoidance of negative affect” and “maladaptive cognitive appraisal”: results showed that prolonged grief severity was associated with a reduced specificity in narrating non-loss-related memories and an increased level of negative appraisals for self-defining memories. Furthermore, these manifestations were

observed in bereaved parents from different cultures, but were moderated by personal value orientations (e.g. traditional-vs.-modern values).

The empirical findings from the three studies were integrated to draw general conclusions and to give theoretical implications in relation to the emotion-memory interaction: ventral and dorsal neutral pathways as the neural basis, negative bias as a behavioral feature, and grief-related memory disruptions as a psychopathological mechanism of prolonged grief. Particular focus is given to the discussion of the cultural effect in the emotion-memory interaction combining the cultural background and cultural components. These theoretical discussions provide suggestions for clinical practices in terms of clinical interventions for pathological emotional memory, and multiculturalism in psychotherapy.

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ABBREVIATIONS

AMG	Amygdala
AMT	Autobiographical memory task
BMA	Bayesian model averaging
BMS	Bayesian model selection
CaR-FA-X model	"Ruminative thinking"-"functionally avoidance"-"cognitive impairment" model
CFA	Confirmatory factor analysis
CG	Complicated grief
DCM	Dynamic causal modeling
DSM-5	The diagnostic and statistical manual of mental disorders, fifth edition
FDR	False dicovery rate correction
fMRI	Functional magnetic resonance imaging
FR	False alarm rate
FUS	Fusiform gyrus
HPC	Hippocampus
HR	Hit rate
ICD-11	International Classification of Diseases, eleventh revision
IOG	Inferior occipital gyrus
OFC	orbitofrontal cortex
PCG	Posterior cingulate gyrus
PG	Prolonged grief
PGD	Prolonged grief disorder
PGDS	Prolonged grief disorder scale
PVQ	Portrait values questionnaire
SD	Standard deviation
SVDMT	Self and value defining memory task
SPL	Superior parietal lobe
VOI	Volum of interest
WHO	World health organization

1. INTRODUCTION

Emotion and memory are hardly new themes in psychological research. Traditional behavioral studies have investigated the influence of emotion on memory performance and learning. The flourishing neuroscience studies aim to identify the neural circuits and cellular mechanisms, by which emotion stimuli are processed and memory processing is modulated. Researchers in the field of clinical psychology have a tradition to examine the emotion-memory interaction as a psychopathological function for mental disorders, particularly in related to the stress- and mood-related disorders. Despite the substantial of literatures, it is still not easy to conclude the influence of emotion, whether it enhances or inhabits memory, or has no effect.

The following theoretical background firstly introduces the conception of schema to describe the structure of memory organization. The arousal-biased competitive process between bottom-up saliency and top-down modulation is then highlighted as a potential mechanism how emotion affects perception and memory. These reviews inspire an interest to investigate the processes of emotion-memory interaction, with the guidance of the theoretical framework that bottom-up and top-down processes drive psychophysiological arousal to modulate memory formation and retrieval. The main aim of the current thesis is to investigate emotion-memory-interaction processes in related to neural exploration and clinical application. Therefore, the theoretical background identifies an extensive brain network supporting bottom-up process and top-down modulation during emotional memory formation for the first neuroscience study. In a clinical application, characteristic disruptions in the autobiographical memory system that are seen as the core psychopathological function of prolonged grief are reviewed in terms of bottom-up (i.e. preoccupation of loss-related memories) and top-down (i.e. functional avoidance of negative affect and madaptative cognitive appraisal) mechanisms. This thesis stresses the context effect that culture shapes the memory processes following traumatic events.

The current thesis consists of three empirical studies, aimed to investigate neural basis during memory formation, clinical manifestations in memory retrieval and the influence of culture on bottom-up and top-down processes regarding the psychopathological mechanisms of grief. Specifically, the Study 1 on neural exploration utilizes dynamic causal model in fMRI to identify an effective neural connectivity in which memory formation is affected by facial emotions. The clinical studies respectively adopt an emotion cue-inducing memory retrieval task (Study 2) and an elaborative autobiographical remembering task (Study 3) to examine the

association between autobiographical memory retrieval and grief intensity across different cultures. The findings are then integrated in a general discussion on the theoretical and practical implications.

2. THEORITICAL BACKGROUND

2.1 Bottom-up and Top-down Processes in Memory and Emotion studies

2.1.1 A constructivist perspective on memory formation and retrieval

Constructivism psychology emphasizes that learning is driven by environmental situations and simultaneously regulated by self. Specifically, learning is a self-organized process by a constant antagonism between internal, subjective mental states and external reality (Piaget & Cook, 1952). Memory is preserved as the past-as-understood, modifying the exact event as it actually unfolded, encompasses a variety of factors, including motivation, interest, or state of receptivity during formation (Iran-Nejad, 1995). In particular, the role of schema is highlighted functioning to organize memories within cognitive structure.

Schema is a cognitively associative network structure that encompasses abstract representations of the similarities or commonalities across events (Ghosh & Gilboa, 2014). Schema is seen as the intrinsic organizer of mental states, which originates from the sources of self-regulation and aids the maintenance and development of personal meaning system (e.g. self-construct, world assumptions and values) (Janoff-Bulman, 1989; Kendzierski, 1994; Lau, 1989). Schema literature consistently identifies the following functions: guiding behavior; facilitating encoding of new information, including inferential elaboration; and expediting retrieval processes (for a review see Ghosh and Gilboa, 2014).

Schemas are adaptable that constantly develop and are affected by incoming sensory experience, in the course of interaction with social and physical environment (Ghosh & Gilboa, 2014; Mandler, 1992). Specifically, during learning stage (e.g. memory formation), the adaptability of schemas involves two processes by incorporating environmental elements into a schema without challenging the existing relationships within the schema, and by modifying a schema under pressures of new environmental elements (Piaget & Cook, 1952). The activation of schemas proceeds automatically from concrete to general schemas (bottom-up), also from high-level schemas, which constrain perception and concretion, to lower schemas (top-down) (Mandler, 1992). Theoretically, the evolution of schema indicates a two-route organization of memory schema: bottom-up route refers to a privileged process or direct access to the concrete and specific events or that will be integrated or lead to the adaptability of higher-level schemas;

top-down route refers to the priority of activating higher-level schemas that guide memory encoding and tracing.

Indeed, extensive versions of the two-route memory schema can be found in memory literatures. Wang and Conway (2004) posited a reciprocal relationship between self-schema and autobiographical memory, in which the self can modulate the processes of encoding, organization, and retrieval of autobiographical memories (top-down), and autobiographical memories in turn function to develop, express and maintain the culturally sanctioned self (bottom-up). Over memory consolidation, Conway and Pleydell-Pearce (2000) conceptualized an autobiographical knowledge base that a database of memories is hierarchically arranged with general summaries of broad categories of lifetime periods at the top and increasingly specific details of individual events at the bottom. Voluntary retrieval of specific event details requires navigating down this hierarchy (top-down). However, retrieval can also occur via direct, involuntary access to the concrete and situation-specific event representations in the memory hierarchy, thus bypassing the hierarchical search (bottom retrieval).

Overall, memories of everyday experiences can be deliberately organized by different levels of schemas, which are constantly developed. The organization of memory schema provides routes by which concrete experiences interact with existing schemas during memory formation and retrieval.

2.1.2 Emotional influence on cognitive process

2.1.2.1 Emotion components

Evolution has endowed most organisms with inherent nervous mechanisms for detecting and evaluating internal states and external environments as beneficial or harmful to their existence and urgency of their different needs and motive states (Bower, 1992). These mechanisms form the fundamental and biological properties of emotion, such as positive-vs.-negative activation, or approach-vs.-withdrawal (Murphy *et al.*, 2003a; Watson & Tellegen, 1985). Based on these original tendencies, human further develops a broader range of emotions and a more complex and differentiated set of emotional appraisals that involve culturally specific interpretations of situations, such as grief, guilt, hostility, contentment, fondness and so on (Shaver et al., 1987).

From a constructivist view, emotion consists of the concatenation of a cognitive evaluative schema with physiological arousal (Mandler, 1992). Gross and Thompson (2007) proposed a

"situation-attention-appraisal-response sequence" to present the modal model of emotion. Emotions are evoked in a psychologically relevant situation that can be external (e.g. external stimuli) or internal (i.e. mental presentations). Situations are attended to in various ways, implicitly or explicitly, giving rise to appraisals that constitute the individual's assessment of the situation's familiarity, positive or negative, and value relevance. These appraisals give rise to emotional responses involving changes in behaviors, neurobiological reaction, and personal experiences (e.g. memories and self-schema). Thus, an emotion encompasses two main components: emotional arousal and evaluation.

2.1.2.2 Emotional functions: arousal-biased process

The fundamental feature of an emotion is to elicit psychophysiological arousal that refers to a continuum that varies from calm to excitement responses in terms of psychological and physiological reactions. In the psychological process, emotional arousal functions to direct attention that allows a particular stimulus (or its location) to be prioritized in attention and garner more neural resources for its representation (Bower, 1992). As a result, emotional arousal shows a bias on enhancement-vs.-impairment in perception and memory (Mather & Sutherland, 2011). Regarding physiological responses, arousal co-occurs with increased autonomic nervous system activities (e.g. increased heart rate, sweating, and pupillary responses) (Bradley et al., 2008; Ekman et al., 1983), as well as enhanced activities in central nervous system such as primary and secondary visual cortex (Lang *et al.*, 1998).

Emotional arousal can affect the selectivity of perception and memory, which is interpreted by the arousal-biased competition between bottom-up vs. top-down processes (Mather & Sutherland, 2011). The bottom-up refers to emotional influence on the nervous system due to extrinsic properties of the stimuli. For instance, stimuli that move suddenly or are brighter than their surroundings attract attention (i.e. bottom-up saliency) (Lee et al., 2014). The saliency of the stimuli has a capability to elicit ordinary cognitive factors such as increased rehearsal, enhanced attention and deepened elaboration, which may be sufficient to account for the memory advantage observed for emotional stimuli (Hamann, 2001). The mechanism of bottom-up saliency mechanism is highly sensitive to environmental context and relevant to various non-declarative forms of memory (i.e. implicit memory), such as procedural learning, priming and reflexive conditioning) (LaBar & Cabeza, 2006).

The top-down process refers to emotional influence on the nervous system due to extra-retinal effects such as intrinsic expectations, knowledge and goals (Baluch & Itti, 2011). For instance, task goals or internal expectations help determine the priority of attentional allocation. The top-down modulation is relevant to emotional evaluation, a process that involves the perception and categorization of emotional stimuli (Dolcos et al., 2004a). Emotional evaluation entails a cognitive analytic mechanism whereby individual uses preexisting schema (e.g. internal expectations, working self) to evaluate current scene as positive or negative (i.e. emotional valence), or as harmful or beneficent (Mandler, 1992). The cognitive judgement will guide the attention to task-relevant stimuli and ignore irrelevant distractions (i.e. selective attention), and influence working memory performance (Gazzaley & Nobre, 2012).

In general, according to the arousal-biased competition model, external stimuli, and internal thoughts, or stress hormones elicit emotional arousal and modulate the strength of competing mental representations, enhancing memory for items that dominate the contest for selective attention (Mather & Sutherland, 2011).

2.1.3 Emotion-memory interaction based on arousal-biased process

2.1.3.1 Bottom-up saliency on memory performance

Emotion-memory interaction refers to the modulatory effect of emotion on different stages of memory processing, including encoding (Dolcos *et al.*, 2004a; Ritchey *et al.*, 2011), consolidation (McGaugh, 2004), and retrieval long-term retrieval process (Dolcos et al., 2005; Maratos et al., 2001). Emotional effects can occur at least in two conditions. First, emotional characteristics of a stimulus or an event (i.e. arousal-inducing stimuli) affect the encoding and retrieval of targeted memories. Experimentally, it has been observed that emotionally arousing stimuli, such as stories (Cahill et al., 1996), pictures (Hamann et al., 1999), and words (Buchanan & Lovallo, 2001), are better remembered than similar materials without emotional value. An example is the research interest in emotional face memory (D'argembeau & Van der Linden, 2007; Johansson et al., 2004; Patel et al., 2012). For example, faces with one negative expression (e.g. sad, fear, angry etc.) were recollected to a greater extent than both positive and neutral faces (Johansson et al., 2004).

Second, in addition to external information, internal states of affairs for dealing with the environment, namely emotional states (e.g. stress and mood) can affect perception and memory. One experimental approach is to place participants into different arousal (high vs. low) or

valence (positive vs. negative) states, which results in global processing biases. For example, individuals in an induced positive mood state were more likely to base object similarity judgments on global features and those in a negative mood state were more likely to base their judgments on local features (Gasper & Clore, 2002). Moreover, the memory bias has been found in the studies of mood-congruity effect. Moods build gradually, and typically last longer and express less intensive than emotions (Lang, 1979). According to the mood-congruity hypothesis, people in a given emotional or mood state give more attention to stimulus events, objects, or situations that are affectively congruent with their emotional states (Bower, 1981). Specifically, being in a negative mood or being depressive promotes recall of negative stimuli and makes an individual prone to judge others in a negative way, whereas positive moods facilitate recall of positive stimuli and making positive judgments about others (Schmid & Mast, 2010).

Overall, these studies illustrate that emotion-charged stimuli and events receive perceptual enhancement by attention during both memory encoding and retrieval processes. One's attention is driven by emotional saliency that the stimuli have more intensive emotional properties than the background or personal mood grants a preferential access to some categories of emotional events. The memory performance that is influenced by extrinsic properties of the stimuli, in which emotional evaluation engages rarely or implicitly, consists with the process of bottom-up saliency.

2.1.3.2 Top-down modulation: the role of elaborative processing

Although emotional stimuli can enhance learning (Hamann, 2001; Roozendaal & McGaugh, 2011), recognition memory studies often found no effect or even inversed effects of emotion on memory performance, while response bias in the subsequent recognition task was robustly more liberal for emotional items (Dougal & Rotello, 2007; Johansson et al., 2004; Windmann et al., 2002). Two factors have been extensively discussed, the role of elaborative processing and the role of perceptual enhancement by attention to emotional stimuli.

In the learning stage, encoding conditions affect formation of emotional memories. Emotional enhancement was more often found for verbal or script material (clips, photographic scenes, taboo words) than for memory of faces, which were less easy to verbalize and showed less inter-item association strength (Johansson et al. 2008). Shallow encoding tasks more often report memory enhancement than deep encoding tasks (Jay et al., 2008; Ritchey et al., 2011). Such findings suggest that semantic and elaborative processing plays a different role in

memories of emotional and neutral information. It was suggested that pre-attentive arousal mechanisms distinguished emotional from neutral information, which then could be used to increase post-stimulus elaboration contributing to enhanced memory for emotional stimuli (Christianson, 1992). When resources are plenty, only emotional stimuli benefit from that additional attention. When resources are sparse, e.g. during dividing attention conditions, this has more detrimental effects on neutral than on emotional stimuli, that relies less on elaborative processing (Kensinger & Corkin, 2004; Kern et al., 2005; Talmi et al., 2007).

The effect of elaborative process has been also observed in the retrieval process. Previous studies found that items with negative emotions showed more robust effects on memory when subject elaborately recollect memories (Kensinger & Corkin, 2003; Ochsner, 2000). For example, emotion affects memory in recall memory tasks that require elaborative retrieval and conscious recollection of past events, but not on recognition tests that could be solved based on stimulus familiarity (Johansson et al., 2004). Independently, negative emotions also affect the response criterion in both recall and recognition tasks. This finding indicates that an elevation of the number of correct identification of old items is accompanied by an increase of incorrect recognition of new items (false alarms) (Dougal & Rotello, 2007; Windmann & Kutas, 2001) or semantically related items (false memories) (Budson et al., 2006).

Therefore, the elaborative process is a mechanism of top-down modulation, as it involves intentionally deep coding of emotional information. The conscious encoding and remembering can be elicited and guided by personal goals, expectations or plans, which further mobilize mental resource to elaborative process of arousal-inducing stimuli (e.g. deep coding, associating them with previous experiences, comparison etc.). As a result, memories these processed events or stimuli with emotional properties are enhanced in memory consolidation or labeled with a priority for retrieval.

2.1.4 Process-oriented emotion-memory interaction

According to emotional arousal-biased process, physiology arousal driven by the emotional properties influence the cognitive process, such as perception and attention. The findings of emotional effects on memory performance and the elaborative process indicate that the arousal-biased competition of attention may affect the two memory-schema routes. Specifically, emotional saliency captures attention to the events with emotional properties, which can strengthen the bottom-up encoding of memory process and drive a preferential access to

emotional events during retrievals. Meanwhile, the elaborative processing of emotions involving preexisting schemas has a top-down modulation to mobilize mental resource for different stages of memory process.

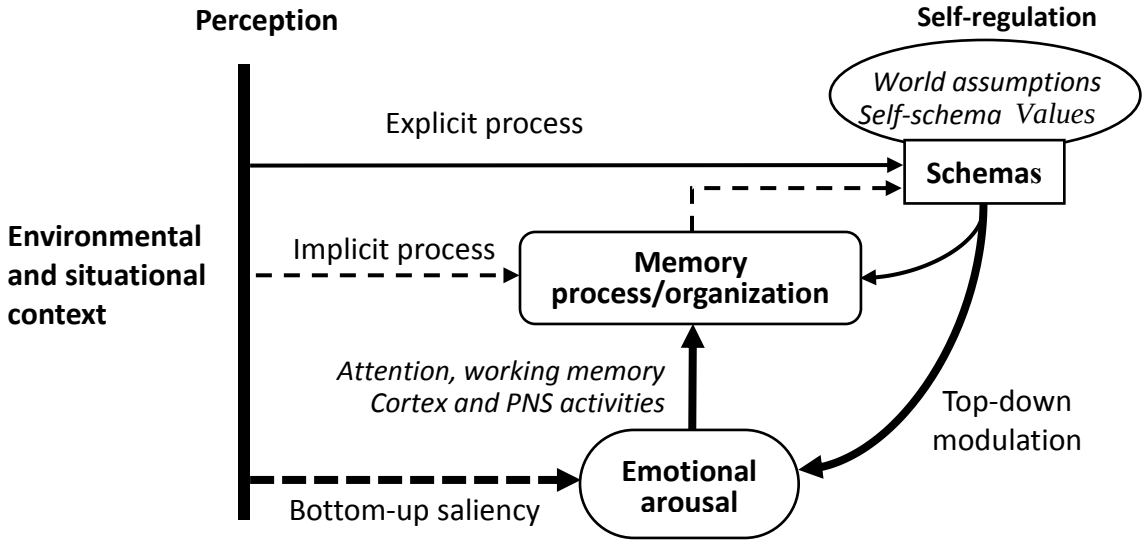

Figure 1. Illustrations on bottom-up and top-down processes in emotion-memory interaction

Although bottom-up and top-down processes have been implied or discussed in different fields of cognitive studies (Mandler, 1992; Mather & Sutherland, 2011), the constructivist perspectives on learning, memory and emotion provide a theoretical background to integrate the understandings. According to the constructivism, emotional memories are the products of the interaction between environmental context and self-regulation. The hierarchical memory organization from episode experiences to schemas offers the routes by which emotion arousal drives the selectivity of mental resource (e.g. attention and working memory) to affect memory formation and retrieval. Illustrated in Figure 1, there are two principal routes in the memory schema: bottom-up (i.e. concrete and specific events support the adaptability of higher-level schemas) and top-down (the priority of activating higher-level schemas that guides memory encoding and tracing). Both arousal-inducing stimuli and emotional states have a motive force to drive psychophysiological reactions such as attention, working memory, cortex activity and autonomic nervous system activity. The motive force may have two originations: stimulus saliency and personal goal/action plan. Stimulus saliency captures attention to the events with emotional properties, which can strengthen the bottom-up encoding of memory schema and drive a preferential access to emotional events during retrievals. Meanwhile elaborative processing of discrepancies between situations and personal goal/action plan (emotional evaluation) invokes

existing schemas and has a top-down modulation to mobilize mental resource for different memory processing.

Furthermore, the perspective of process-oriented emotion-memory interaction provides a theoretical framework to investigate learning performance, psychological mechanisms and clinical manifestations on the relationship between (normal or pathological) emotion and memory processing. In the following introduction, the thesis will apply the bottom-up and top-down perspectives to investigate the neural basis of emotional facing processing, and the psychopathological manifestations of memory disruptions following bereavement.

2.2 Neuroscience Exploration on Bottom-up and Top-down Processes in Emotion-memory Interaction

The emerging discipline of cognitive neuroscience on emotion has identified the synergistic reactions among the brain systems to demonstrate how emotion and memory interact at the brain level (Le Doux et al., 1996). Major brain systems include amygdala, basal ganglia, lateral prefrontal cortex, anterior cingulated, and ventral and medial orbital frontal cortex (a review seen in Gupta & Srinivasan, 2009). Particularly, previous studies have emphasized the interaction between the amygdala and the memory system within medial-temporal lobe (Dolcos et al., 2004b; Phelps, 2004). The amygdala plays a key role in the detection of emotional cues and in the emotional modulation of memory circuits (Paz & Pare, 2013). Its enhanced functional coupling with the hippocampus during encoding promotes emotional memory formation (Ritchey et al., 2008) and increasingly predicts long-term emotional memory retrieval (Smith et al., 2006).

Furthermore, the amygdala-hippocampal connection collaborates with other brain regions supporting memory to represent different emotional valences. Several lines of evidence point to the contribution of more than one route to emotional memory enhancement. First, emotion can evoke strong arousal that facilitates participation of multiple regions in perceptual and attentional processes (Ciaramelli *et al.*, 2008; Kensinger *et al.*, 2007; LaBar & Cabeza, 2006). These mechanisms can be recruited in conditions of emotional arousal, irrespective of negative or positive valences (Cahill & McGaugh, 1990). Functional connectivity studies found that emotion could drive robust attention processing along parallel forward pathways from visual regions to the frontal cortex, where amygdala activity lacked sufficient modulation ability to gate the information delivery (Dima et al., 2011; Fairhall & Ishai, 2007). These studies support a

"bottom-up" fashion that emotion stimuli are operated along with facial perception, rather than an independent mediating fashion from the amygdala. Nonetheless, whether this bottom-up process can influence memory formation remains largely unexplored. Alternative to the bottom-up fashion, top-down processes may influence memory formation. A prioritized candidate mechanism for emotion-driven encoding is the prefrontal cortex (Kumfor et al., 2013; Simons & Spiers, 2003). For example, the orbitofrontal cortex, a region implicated in representation of affective value and behavioral guidance, has modulatory influences on the amygdala-hippocampus connectivity that links to perceptual encoding of negative stimuli (Smith et al., 2006). In addition, the prefrontal cortex constitutes a direct network with the hippocampus that mediates emotional valence (positive, negative or neutral) (Kensinger & Corkin, 2004), which is more sensitive to positive information (Ritchey et al., 2011).

Overall, emotion can enhance the recognition of studied emotional stimulus, but it also changes the response criteria, i.e. increase the number of false alarm. Bottom-up and top-down neural mechanisms may play an important role in perception and recognition memory operations of emotional stimuli, but it is currently unclear whether emotion engages bottom-up or top-down neural mechanisms during memory formation and whether these mechanisms can explain the variation of emotional influences on recognition memories. Therefore, the first study utilized Dynamic Causal Modeling (DCM) of functional magnetic resonance imaging (fMRI) (Friston et al., 2003) in an incidental learning task of faces with positive ("happy"), neutral and negative ("angry") emotional expressions, aimed to characterizing an effective neural network with two proposed emotion-memory-interaction mechanisms during memory formation, bottom-up process and top-down modulation. Specifically, the bottom-up process assumes that emotion works simultaneously with the perception that contributes to the memory formation. Top-down modulation emphasizes the primary role of prefrontal cortex on the emotional processing.

2.3 Grief and Autobiographical Memory: A Clinical Investigation on the Effect of Emotional State on Memory

2.3.1 Grief and its manifestations

Clinical psychology considers emotion and memory processes as crucial psychopathological functions for mental disorders in the wake of stressful or traumatic life events. For instance, prolonged grief disorder (PGD) is a psychopathological profile of disabling

responses to bereavement, for some individuals who have experienced the loss of loved one and whose grief responses remain static or even deteriorate debilitating symptoms beyond the normal mourning course (e.g. 6 months or longer in some cultures). Individuals suffering from PGD are overwhelmed by negative emotions, including sadness and sorrow that are primitive from the loss of love, as well guilt, anger, shame and self-blame that secondarily build up from catastrophic misinterpretations on bereavement. Meanwhile, they manifest memory-related symptoms such as a persistent and pervasive yearning and longing for the deceased, a preoccupation with the images and thoughts of the deceased, and a rumination of bittersweet memories about the deceased person and other related experiences (Maercker *et al.*, 2013; Maercker & Znoj, 2010).

As discussed above that emotion influences the memory process, it is reasonable to adopt a holistic view of emotion-memory interaction as the psychopathological function of prolonged grief (PG). Following stressful events, one's overwhelming emotions may have an impact on the memory processes, such as encoding and consideration of the traumatic events (e.g. sensory features of traumatic experiences remain vividly in a long-term perceptual memory) (Brewin, 2013), and involuntary or voluntary memory retrieval (e.g. intrusion of traumatic memories) (LaBar & Cabeza, 2006). The alterations or disruptions in memory process following bereavement (e.g. preoccupation with the images and thoughts of the deceased) are associated with grief-related emotions (e.g., negative emotions trigger loss-related memories more easily than positive emotions) or grief mood (e.g., individuals with severe PG report a larger proportion of loss-related memories than their counterpart without PG, Maccallum & Bryant, 2010).

2.3.2 "Failure to integrate loss-related memories" hypothesis in prolonged grief

Clinical psychology has a tradition to study the alterations in autobiographical memory as a psychopathological function of mental problems. Autobiographical memory encompasses memories of personal events from an individual's life. The great interest in autobiographical memory consists with the traditional view in psychology that the onset and maintenance of mental problems can be interpreted in the frame of personal biographical experiences. Furthermore, autobiographical memories play an important role in the development of self-definition and regulation (Prebble, et al., 2013). Wang & Conway (2004) postulates a two-way constructive process, in which the self can modulate the processes of encoding, organization, and retrieval of autobiographical memories, and autobiographical memories in turn function to

develop, express and maintain the culturally sanctioned self. According to process-oriented perspective, this reciprocal relationship between autobiographical memory and self may provide two important routes by which emotion affects the memory functions in the organization of self-construal. Presumably, the bottom-up saliency of emotional events may enhance the autobiographical remembering in relation to self-schema, while self-regulation activated by emotions may have an effect in encoding, consolidating and retrieving autobiographical memories.

Stressful life events such as bereavement can threaten or disrupt the autobiographical memory-self construct. First, traumatic events can challenge, shatter or shift personal meaning system, such as self-identity, views on assumptive world, beliefs, life goals and purpose (Gillies & Neimeyer, 2006; Janoff-Bulman, 1989; Park, 2010). Bereaved individuals thus confront with reaffirmation or reconstruction of sense of self and self-identity such that they may feel difficulties to accept the reality of death and integrate loss-related memories. According to the perspective of Conway and Pleydell-Pearce (2000), traumatic experiences present a threat to current plans and goals to which the working self cannot adopt. The failure that currently active goals mediate integration of the traumatic experiences into the autobiographical knowledge database causes the intrusion of traumatic memories. Accordingly, the bereavement event that is beyond personal goals and life expectations may interfere with the coherence of autobiographical knowledge, and loss-related memories appear to be poorly elaborated and inadequately integrated into its context in time and place with other autobiographical memories. Maccallum and Bryant (2013) claim that maladaptive process of autobiographical memories following bereavement (e.g. misinterpretation of the bereavement experiences and maladaptive emotion regulation) reinforces a merged self-identity in which bereaved person's identity is constructed around or entwined with the deceased. In turn, the modified self-identity is associated with goals and motivations that affect the encoding and retrieval of information in autobiographical database, such as impaired retrieval of specific memory. Therefore, central to numerous models of the maintenance and development of prolonged grief is the pathological pathway of integrating memories related to the bereavement (Boelen et al., 2006; Maccallum & Bryant, 2013). A great deal of empirical studies has revealed some characteristic manifestation of memory disruptions due to the “failure to integrate loss-related memories” hypothesis, which is

conceptually interpreted by three cognitive processes: the preoccupation of loss-related memories, functional avoidance of negative affect and maladaptive cognitive appraisal.

The following summarizes empirical evidences based on a shallow and an elaborative task for autobiographical remembering (i.e. retrieving and narrating autobiographical memories). In a widely used Autobiographical Memory Task (AMT), participants are asked to retrieve events that happened at a particular time and place (i.e. specific memory) in response to emotional cue words (e.g. happy, sad, lonely, brave etc.). This task is time-limited (30 or 60 seconds) and prompted to recall the first memory that emerges in participants' mind. Therefore, the AMT involves a shallow memory retrieval that mainly targets at the bottom regions of hierarchical autobiographical knowledge base, namely the concrete and situation-specific memories. By contrast, Self-defining Memory Task (SDMT) elaborates the retrieval process by prompting participants to deeply reflect themselves and select some autobiographical memories as reference events of themselves. Self-defining memories are vivid, repetitive and affectively charged, which serve to convey knowledge of distress and achievements and inform individuals about the important conflicts and concerns in their lives (Singer and Salovey 1993). SDMT is thus an elaborative memory task that involves a self-evaluation process during which individuals evaluate themselves based on everyday memories, and make positive and negative appraisals of what they do and who they are (Bauer & Bonanno, 2001; Blagov & Singer, 2004). Hence, the process to search for self-defining memories may function through the top-down hierarchy of autobiographical knowledge base, which mobilizes self-regulation.

2.3.2.1 Preoccupation with loss-related memories: an effect of bottom-up saliency

One of core features of the prolonged grief disorder is the preoccupation with thoughts and images associated with the deceased. In both AMT and SVMT task, individuals suffering from the prolonged grief (PG) had a preferential access to memory related to the deceased than the group without PG (Maccallum & Bryant, 2008, 2010). These memories are affectively charged and specifically presented, as Maccallum and Bryant (2010) found that PG participants' tendency to recall memory related to their loss was particular in response to negative cues.

This feature, preferential accessibility to loss-related memories, accords to the mechanism of robustness of traumatic memories that are usually accompanied with intensive emotion and central to the person's life story and identity of self (see a review by Rubin et al., 2008). First, as an aftermath of traumatic experiences, part of survivors, particularly individuals suffering from

posttraumatic stress disorder (PTSD), experience the involuntary intrusion of vivid and detailed images in which the traumatic sciences are re-experienced as though they were occurring in the present. Involuntary memories consisting of trauma-related perceptions are considered as the result of enhanced perceptual priming (Ehlers & Clark, 2000), increased consolidation in a long-term perceptual memory system, and disassociation with episodic memory (Brewin, 2014). The manifestation of involuntary memories indicates that the perceptual saliency is capable to strengthen the consolidation and accessibility to recall and recognize traumatic memories. Likewise, many PGD patients experience intrusive recollection of emotional events that surround the death. Second, the bereaved submerge in grief rumination that their increasing attention has been devoted to thoughts about the reasons for the loss and the catastrophic implications of general loss-related emotions (Eisma et al., 2014). Bereaved individuals with a high level of grief rumination dwell on loss-related materials such as memories related to grief responses and consequential events following the death of loved one, which can interfere with the acceptance of the reality of death (Eisma et al., 2013). In addition, yearning related to the loved ones' absence, a dominated affect for bereaved person, exacerbates their persistent seeking for the bittersweet memories of the deceased person and other related experiences, such as shared events that happened before his/her death (Maercker & Znoj, 2010). Overall, involuntary intrusion and voluntary recalling triggered by rumination or yearning cause the preoccupation of loss-related memories. The manifestation of preoccupation characterized by perceptual saliency and being emotion-laden supports the bottom-up saliency in emotion-memory interaction for the bereaved.

2.3.2.2 Functional avoidance of negative affect: a top-down modulation

Another characteristic feature of grief-related memory disruptions is overgeneralized narration of autobiographical memories. In the AMT bereaved individuals exhibited a reduced specificity when recalling events that were unrelated to the deceased; but they maintained normal specificity when recalling events related to the deceased (Golden et al., 2007; Robinaugh et al., 2013). The reduced specificity in non-loss-related memory was associated with a higher severity of PG (Boelen et al., 2010a; Eisma et al., 2015). The reduced specificity, also called overgeneral retrieval process, has been considered an important psychological marker of depression and trauma-related disorders, which is often interpreted by the CaR-FA-X model (Williams, 2006). Specifically, a retrieval of autobiographical memory can activate "ruminative thinking" (CaR) that originates from one's repeated rumination of self, symptoms and their implications. This

thinking style strengthens the abstract rumination toward retrievals of general or analyzing events. Meanwhile, "functional avoidance" (FA) serves as a strategy to selectively narrate events in order to generate less emotion distress. Impairment in executive control and cognitive flexibility (X) can impede searching specific exemplar in the hierarchy self-memory system. Recent studies claim that rumination is linked with specific avoidance processes (Stroebe et al., 2007; Eisma et al., 2013). For example, Eisma and his colleges (2013) found that experiential avoidance (i.e. the avoidance of internal experiences including memories) mediated the relationship between grief rumination and grief symptomology.

Furthermore, a retrieval bias was shown in autobiographical remembering, where the reduced specificity has different response patterns to positive or negative cues. In the comparative studies with bereaved individuals without PG, Maccallum and Bryant (2010) found that PG participants' tendency to recall memory related to their loss was particular in response to negative cues. As for memory specificity, Golden et al. (2007) found that PG participants generated a greater proportion of specific memory concerned with the deceased and less specific memory concerned with the living person in response to negative cues, but not to positive cues. Above findings provide a support for the overgeneral hypothesis "functional avoidance of negative affect", which suggests that bereaved individuals tend to avoid loss-related memories and retrieve non-specific memories when narrating memories related to negative emotions.

As a strategy of emotion-regulation, the functional avoidance indicates that higher-level cognitive process modulates memory process driven by emotional effects. Nevertheless, traumatic memories have been found to be immune from the overgeneral retrieval process (Boelen et al., 2010). The grief-related preoccupation with the images and thoughts of the deceased can result in preferential retrieval of loss-related memories and remain specificity in loss-related memories (Maccallum & Bryant, 2008, 2010). Taken together, an assumption can be given that the grief-related disruptions in the autobiographical memory system may be a consequence of two competitive processes between the preoccupation of loss-related memories and the functional avoidance of negative affect. In general, this hypothesis suggests a view that the interaction between bottom-up saliency (i.e. preoccupation of loss-related memory) and top-down modulation (i.e. functional avoidance of negative affect) of emotional influences on memory process gives rise to clinical memory manifestations in relation to the prolonged grief.

2.3.2.3 Maladaptive cognitive appraisal

According to cognitive-behavioral conceptualization (Boelen et al., 2006), PG patients have negative beliefs and misinterpretations of grief reaction, which interfere with the adjustment of the autobiographical database. Empirical studies found that PG symptomatology is associated with stronger endorsement of global negative beliefs about life, interpreting one's grief reactions in a threatening or anxiety-provoking way (Boelen et al., 2003a, 2003b), self-devaluation and negative self-related cognition about the future (Golden and Dalgleish, 2012). These negative beliefs derive from shattered or impaired personal meaning system after the loss. The shifts in personal meaning system have been observed in variably conceived constructs such as assumptive world (Janoff-Bulman, 1992), global meanings (Park, 2010), self-narratives (Neimeyer, 2001), autobiographical schemas (Boelen et al., 2006), or role relationship (Horowitz et al., 1993).

The shifted personal meaning system can execute a top-down modulation on the integration process of loss-related memories. Maccallum and Bryant (2013) claim that failure in integrating autobiographical memory involves maladaptive cognitive appraisals and emotion regulation strategies. Maladaptive appraisals of autobiographical experiences will be associated with the tendency to retrieve loss-congruent memories, which in return will negatively affect emotion regulation strategies, such as avoidant coping (e.g. self-distraction, denial, behavioral disengagement, self-blame and substance use) (Schnider et al., 2007), rumination or avoidance strategies (e.g. experiential avoidance of emotions, thoughts, and bodily sensations) (Boelen et al., 2010b). Consequentially, prolonged grief manifests in two dysfunctions of autobiographical memory: the centrality of loss-related memories and maladaptive appraisals for them, which have already been supported by a large body of empirical studies (Gass & Chang, 1989; Maccallum & Bryant, 2008, 2010). For example, bereaved individuals have been found to use grief-related memories as a reference of self-defining memories, particularly for individuals suffering from severe PG (Maccallum & Bryant, 2008). Stroebe and Schut (2010) further argue that mourners need go through oscillations between positive and negative affect/ (re)appraisal of both loss-related and restoration-related stressors. As a result, persistent negative effect enhances grief, whereas positive reappraisals sustain the coping effort. Thus, negative appraisal of loss-related autobiographical memories is critical to indicate the level of PG severity as a maladaptive outcome of failure in memory integration.

In general, due to the failure to integrate loss-related memories, personal state of PG has an impact on elaborative autobiographical remembering including memory recollection and evaluative process through top-down modulation. Specifically, a higher level of PG severity may be associated with a preferential access to loss-related memories as reference events for self (e.g. self-defining memory), accompanied by negative appraisals.

2.3.3 Culture, autobiographical memory and grief

To appraise a situation based on internal action plans or motivations is one of main components of emotional response (Gross & Thompson, 2007). Many of these action plans and goals are social and require interaction with others. Social behavior seems to be tightly coupled to emotion. As emotions can be thought of as states that coordinate homeostasis in a complex, dynamic environment, emotions will participate in regulating social behavior (Adolphs, 2003). Thus, one aim of the current thesis is to investigate emotional memory in the social context.

At the macro level, the social context is a set of ecological, historical and political conditions shared by a group, which is termed as culture. Culture cannot only diversify expression of grief (Rosenblatt, 2008), grieving processing (Bonanno et al., 2005), coping processing to stress and trauma (Chun et al., 2006), but also affect everyday autobiographical memory (Ross & Wang, 2010) and remembering of trauma (Jobson et al., 2014). Thus far, the majority of the literature pertains grief and memory from Western cultures. Some questions emerge: Do the characteristics of the disruptions in autobiographical memory following bereavement hold in different cultural contexts? Do cultural components (e.g. personal values and social beliefs) moderate the bottom-up and top-down processes of integrating autobiographical memories over the grieving course? Therefore, the second research in the current thesis exerts a cross-cultural comparison between China that has a long historical tradition and presents typical collectivist contexts (Triandis et al., 1990), and Switzerland that elevated individualist values and has quite egalitarian social norms (Group, 1994). Cultural differences in the associations between grief severity and memory disruptions further explained in terms of cultural background and cultural components.

2.3.3.1 Cultural effects on autobiographical remembering

Western and non-Western cultures, such as European versus Chinese cultures, are commonly characterized by distinct construal of the self, others and the interdependence between the two (Hazel R Markus & Kitayama, 1991; Hazel Rose Markus & Kitayama, 2010). In

individualistic cultures (typically Western) that perceive self as an independent entity, memories of personal experiences help individuals to distinguish themselves from others and contribute to an autonomous self-construal. While in collectivistic cultures (typically Eastern) that perceive self as an interdependent entity, autobiographical memories are less relevant to self-definition but more interconnected with others and places within a network of relationships. Cultural concept of self can affect the accessibility of autobiographical memories so that cultural differences are evidence in the content and specificity of personal memories (Ross & Wang, 2010). For example, when comparing self-descriptions between American and Chinese adults, Wang (2001) found that Americans reported lengthy, specific, self-focused, and emotionally elaborate memories, whereas Chinese provided brief memories centering on collective activities, and included a great number of social roles in their self-descriptions.

In addition, recently in the field of health and clinical psychology, a rising interest is to portray the underlying mechanisms about how cultural components maintain the cultural similarity and/or facilitate potential cultural differences across distinct social and cultural contexts. The main emphasis has been placed on the role of basic value orientation (Maercker, 2001, Maercker et al., 2015; Wang et al., 2014; Zimmermann et al., 2014), as personal value has been regarded as crucial component of culture and plays a central role in the meaning system of culture (Schwartz, 2014). Maercker et al., (2009) have applied the "Theory of basic human values" (Schwartz, 1992) to clinical psychology and simplified categories as traditional vs. modern values. Traditional values (i.e. conformity, tradition, benevolence, security, and universalism) emphasize collectivism, submissive self-restriction, preservation of traditional practice, protection, and stability; whereas modern values (i.e. self-direction, stimulation, hedonism, achievement, power) present the motivations to pursue personal success and dominance over others or personal gratification. According to the definitions, traditional values are relevant to the interdependent self, as both constructs emphasize relationships with others or groups in a specific social and cultural context. Whereas modern values are relevant to the independent self, as both focus on personal values and self-actualization. Ross and Wang (2010) summarized relationships between cultural self-views and remembering to indicate that culture can influence remembering through different values and beliefs, particularly values pertaining to self. Researches by Robinson and Clore (2002) and Oishi et al. (2007) found that beliefs and values could influence retrospective reports of emotional experiences. Therefore, the current

study will examine whether value orientations can influence bereaved individuals' autobiographical remembering.

2.3.3.2 Cultural effects on psychopathological process following traumatic events

According to the "threat to conceptual self model" (Jobson, 2009), traumatic memories can override the cultural distinctions in interdependent vs. independent orientation in self-construal. It suggests that a traumatic event that challenges personal survival can activate an autonomous goal to protect personal safety and to personally control and master the situation, regardless of the original dominant self-orientation. This perspective has been supported by the findings of empirical studies that the differences in self-construal between independent versus interdependent orientations were reflected in everyday memories but not in traumatic memories (Jobson et al., 2014; Jobson & O'Kearney, 2006; Jobson & O'Kearney, 2008). Following traumatic events, despite different cultural backgrounds, individuals with PTSD manifested pan-cultural disruptions in the autobiographical remembering such as cultural similarities in the phenomenological properties (i.e., recollection, language, fragmentation, and rehearsal) of the trauma memories (Jobson et al., 2014), and an overgeneral retrieval style (Jobson & Cheraghi, 2015). These studies suggest that although culture affects both what people remember and how they use their memory in general (Ross & Wang, 2010), the psychopathological function of the preoccupation of traumatic memories (e.g. loss-related memories) may apply to people from different cultural backgrounds.

Nevertheless, culture has an impact on the coping strategy of "functional avoidance of negative affect". Autobiographical memory has a social function, and telling an autobiographical memory can entail interpersonal or social interactions (Bluck, 2003). Autobiographical remembering among bereaved persons would therefore be associated with the individual's severity of prolonged grief, and would also be affected by their strategies of coping with grief, particularly their tendency towards thinking and talking about the deceased and bereavement events (i.e. deliberate grief avoidance vs. disclosure intention) (Baddeley & Singer, 2009; Eisma et al., 2013). For example, previous cross-cultural studies have showed cultural differences between Chinese and Western cultures in the grief expression and grieving processes of bereaved parents (Bonanno et al., 2005; Lalande & Bonanno, 2006; Xiu et al., 2016). A study by Xiu et al. (2016) suggested that Swiss bereaved parents shared a similar grief symptom profile with the Chinese sample, but manifested more severe grief-related preoccupation than the Chinese

bereaved. These cultural differences were attributed to the independent self of Swiss bereaved parents who prioritized the private internal aspects of self and self-reliance. The authors speculated that Swiss parents with an independent self-construal might focus on personal perceptions and their connection with the child, which may result in a preoccupation with vivid and emotional images and thoughts of the deceased (i.e. specific loss-related memories). In contrast, the interdependent self in the collectivistic Chinese culture emphasizes the public aspects of self and relies on social support. The death of a child was originally stigmatized as an unlucky or cursed event in traditional Chinese culture and having no child is extremely non-filial to family in Confucianism (Zheng & Lawson, 2014). Loss of a child in China may cause a conflicting situation for the parents who may wish to seek social support but feel the pressure of a taboo about discussing their bereavement experiences. This speculation was supported by the findings of Bonanno and his colleges (2005) that Chinese parents exhibited a more intensive deliberate grief avoidance of thinking and talking about the deceased than the American bereaved parents. During autobiographical remembering, deliberate grief avoidance may occur in accordance with the functional avoidance hypothesis of reduced memory specificity (Williams, 2006).

Overall, it can be assumed that the psychopathological pathway of "failure to integrate loss-related memories" in prolonged grief might hold similar characteristics in different cultures. Culture and culture components may have different effects to shape the competitive processes between "preoccupation of loss-related memories" and "functional avoidance of negative affect".

3. THE PRESENT THESIS

3.1 Aim and Research Questions of the Thesis

The main aim of the current thesis is to investigate the bottom-up and top-down processes in emotion-memory interaction in terms of a neural exploration and clinical application. The current thesis aims to address the following three research questions.

3.1.1 Research question 1: *Which process model can best explain variations in neural activity during memory formation of emotional faces, bottom-up saliency or top-down modulation?* (Study 1)

The first neuroscience study aims to investigate the role of bottom-up and top-down neural mechanisms in the processing of facial expressions during memory formation. Study 1 utilized Dynamic Causal Modeling (DCM) of functional magnetic resonance imaging (fMRI) to identify effective neural networks supporting an incidental-learning task of faces. Since bottom-up processes are important in perception of emotional faces (Dima et al., 2011; Fairhall & Ishai, 2007) and episodic memory formation (Dickerson et al., 2007; Sepulcre et al., 2008), it is expected that the bottom-up model will best explain memory formation of emotional faces (*Hypothesis 1*).

3.1.2 Research question 2: *Can the interaction between bottom-up saliency (i.e. preoccupation of loss-related memories) and top-down modulation (i.e. functional avoidance of negative affect and madaptative cognitive appraisal) explain the grief-related memory disruptions in grieving parents?* (Study 2 and Study 3)

The second stage of the current thesis includes two clinical studies and aims to explore the relationship between emotional state and memory retrieval. According to the hypothesis "failure to integrate loss-related memory", Study 2 and Study 3 examined three cognitive processes through a shallow and an elaborative autobiographical remembering task. The competitive processes between "preoccupation of loss-related memories" and "functional avoidance of negative affect" during memory consolidation result in the disrupted memory retrieval in terms of grief-related content and memory specificity. It is hypothesized that bereaved individuals with more severe prolonged grief will show a preferential access to loss-related memories and a reduced specificity in non-loss-related memories (*Hypothesis 2.1*). In Study 3, a newly modified elaborative autobiographical memory task (i.e. Self and value defining memory task) will be

used to investigate the top-down modulation on memory narration associated with prolonged grief. It is hypothesized that individuals with more severe prolonged grief would narrate more loss-related memories as reference events of self, and they will provide more negative meanings for their self-defining memories (*Hypothesis 2.2*).

3.1.3 Research question 3: *How does culture shape the cognitive psychopathological processes of prolonged grief?* (Study 2 and Study 3)

As culture diversifies the grieving process and autobiographical remembering, the current thesis further concerns with the cultural effects on the cognitive psychopathological processes in relation to bottom-up and top-down processes in emotion-memory interaction. A cross-cultural comparison was implemented between Chinese and Swiss bereaved parents, as representative samples of Eastern and Western cultures, respectively. It is expected that the bottom-up saliency in emotion-memory interaction associated with the process of "preoccupation of loss-related memories" will be observed across cultures, whereas the top-down modulations of "functional avoidance of negative affect" and "maladaptive cognitive appraisal" will show cultural differences (*Hypothesis 3.1*). Furthermore, the crucial cultural component, traditional vs. modern values, will be introduced to examine cultural differences in memory manifestations. It is hypothesized that personal value orientations will have a moderating effect in the individual differences in memory indexes (*Hypothesis 3.2*). In particular, as traditional values that are conceptually relevant to interdependent self-construal may challenge personal bereavement adjustment, it is expected that traditional values will be associated with top-down modulation, by modulating memory specificity and cognitive appraisal.

3.2 Summary of Study 1

Background: This first study aims to examining how emotional face expression is implemented in neural networks supporting memory formation of faces. Two neural mechanisms underlying arousal-biased process were identified during memory encoding: the bottom-up models assumed processing of emotional face expression along feed forward pathways to the orbitofrontal cortex; the top-down models assumed that the orbitofrontal cortex processed emotional valence and mediated connections to the hippocampus.

Method: Functional brain imaging data was acquired during incidental learning of positive ('happy'), neutral and negative ('angry') faces. Dynamic causal modeling (DCM) was applied on the fMRI data to characterize effective connectivity within a brain network involving face

perception (inferior occipital gyrus and fusiform gyrus) and successful memory formation related areas (hippocampus, superior parietal lobule, amygdala and orbitofrontal cortex). Bottom-up and top-down neural models were constructed and compared in the whole group. We further examined the relationships between effective neural connectivity and behavioral performances in a subsequent memory test.

Results: A subsequent recognition memory test showed an effect of negative emotion on the response bias, but not on memory performance. The DCM findings showed that the bottom-up model family of effective connectivity best explained the data across all subjects and specified that emotion affected most bottom-up connections to the orbitofrontal cortex, especially from the occipital visual cortex and superior parietal lobule (supporting *hypothesis 1*). Of those pathways to the orbitofrontal cortex, the connection from the inferior occipital gyrus correlated with memory performance independently of valence. The response to negative expression on the connection from superior parietal lobule to orbitofrontal cortex was associated with response bias of negative valence.

Conclusion: These findings suggest that bottom-up neural mechanisms support effects of emotional face expression and memory formation in a parallel and partially overlapping fashion.

3.3 Summary of Study 2

Background: As a psychopathological function of prolonged grief (PG) disorder, disruptions in autobiographical remembering (i.e. bottom-up retrieval) have been shown in bereaved individuals in terms of preferred access of loss-related memory and reduced specificity in non-loss-related memory. The present study examined these features in two distinct cultural groups. The cultural differences between these two groups were further investigated in the light of their personal value orientations.

Method: A sample of 30 Chinese and 30 Swiss bereaved parents who had lost their child completed the Autobiographical memory task, in which participants were asked to recall one specific event in response to each emotional cue (5 positive and 5 negative emotional words in total). Each memory was coded in terms of grief-related content (loss-related vs. non-loss-related memory) and specificity (specific vs. non-specific memory). Self-reported scales assesses the PG severity and traditional-vs-modern value orientations.

Results: A negative bias in autobiographical remembering was observed that both Chinese and Swiss participants provided significantly larger proportions of loss-related memory and

specific loss-related memory in response to negative emotional cues than their responses to positive cues. Consistent with previous studies, more severe PG was found to be associated with a greater proportion of loss-related memories and reduced specificity of non-loss-related memories in the combined sample, particularly in response to negative cues (Supporting *hypothesis* 2.1). These manifestations were observed in the Chinese sample as a whole (but more salient in participants with low traditional values), as well as in the Swiss participants with low traditional values (partially support *hypothesis* 3.1). By contrast, bereaved Swiss parents with high traditional values showed deliberate grief avoidance, as more severe PG was associated with a smaller proportion of loss-related memory for negative cues but a greater proportion of specific non-loss-related memory (supporting *hypothesis* 3.2).

Conclusion: These findings indicate that the psychopathological memory retrieval process applies to bereaved parents from different cultural backgrounds; nevertheless, the manifestations of disruptions in autobiographical remembering are moderated by culture and personal value orientations.

3.3 Summary of Study 3

Background: According to the psychopathological hypothesis "failure to integrate loss-related memory" in prolonged grief (i.e. top-down modulation), it was assumed that PG severity would be associated with preferential access to loss-related memories and negative appraisals for self-defining events. This study further investigated the role of personal value orientations and culture in shaping PG responses on an elaborative autobiographical remembering.

Method: In a newly modified memory task, 30 Chinese and 22 Swiss bereaved parents were asked to narrate some specific memories to reflect their self-evaluation of personal traditional (i.e. conformity, benevolence and tradition) and modern values (i.e. self-direction, stimulation and hedonism) (retrieval process). Bereaved parents were then encouraged to appraise the meaning of each narrated memory event (evaluative process). Each narrative was coded in terms of grief-related content (loss-related vs. non-loss related memory) and valence of appraisal (negative meaning and positive meaning). The self-reported Prolonged Grief Disorder Scale (ref ICD-11) assessed PG severity.

Results: Compared with the Swiss sample, the bereaved Chinese parents tended to provide more narrations elaborated with positive appraisals, particularly when they narrated non-loss-related memories. Cross-culturally, both Chinese and Swiss bereaved parents with more severe

PG provided more narratives of loss-related memories particularly in response to modern values (regardless of appraisal quality). They also provided more appraisals of negative meaning remarkably in response to traditional values (supporting *hypothesi*s 2.2 & 3.1 & 3.2).

Conclusion: These findings indicate that the PG severity in bereaved parents is associated with the integration of autobiographical memories and this process is moderated by both modern and traditional values, across different cultures.

4. GENERAL DISCUSSION

In the following section, the findings of the three research papers will be integrated in an overall discussion. The focus is on investigating the contribution of the three papers to theoretical understanding on the neural basis, behavioral characteristics, and clinical manifestations of emotion-memory interaction. The cross-cultural studies inspire a cultural consideration on the relationship between emotion and memory. Finally, implications for clinical practice will be given.

4.1 Theoretical Implications on Emotion-Memory Interaction

4.1.1 The ventral and dorsal neural pathways for bottom-up emotional face processing

In accordance with the theory that emotion operates during memory formation via multiple regions participating in perceptual, attentional or semantic processes (LaBar & Cabeza, 2006), Study 1 revealed an extended network combining facial perception and memory formation related areas that supported emotional face processing, including hippocampus (HPC), amygdala (AMG), posterior cingulate gyrus (PCG), superior parietal lobe (SPL) and orbitofrontal cortex (OFC). This study further identified the effective connectivities by which emotion exerted effects along multiple parallel feed-forward pathways to the orbitofrontal cortex in a bottom-up fashion.

These findings indicate a brain network of ventral and dorsal pathways by which effective connectivities from the visual region to the frontal cortex support emotion and memory processing (See Figure 3). The inferior connections composed the ventral visual stream and engaged functional coupling between the visual cortex and inferior prefrontal cortices (i.e. IOG→OFC), while the superior connections extended upon the dorsal visual stream and connected to dorsal parts of the prefrontal cortex (i.e. SPL→OFC). The ventral pathway supports visual attention and perception (Gregoriou *et al.*, 2009). The SPL can provide attentional assistance for face perception during gaze perception (Hoffman & Haxby, 2000), memory encoding (Uncapher & Rugg, 2005), retrieval (Ciaramelli *et al.*, 2008). Illustrated in Figure 3, the SPL had functional connectivities with the inferior occipital gyrus (IOG), the AMG and the OFC during emotional face processing, indicating that the SPL may play a role to mobilize mental resource to visual attention in the IOG, emotion perception in the AMG and decision making in the OFC.

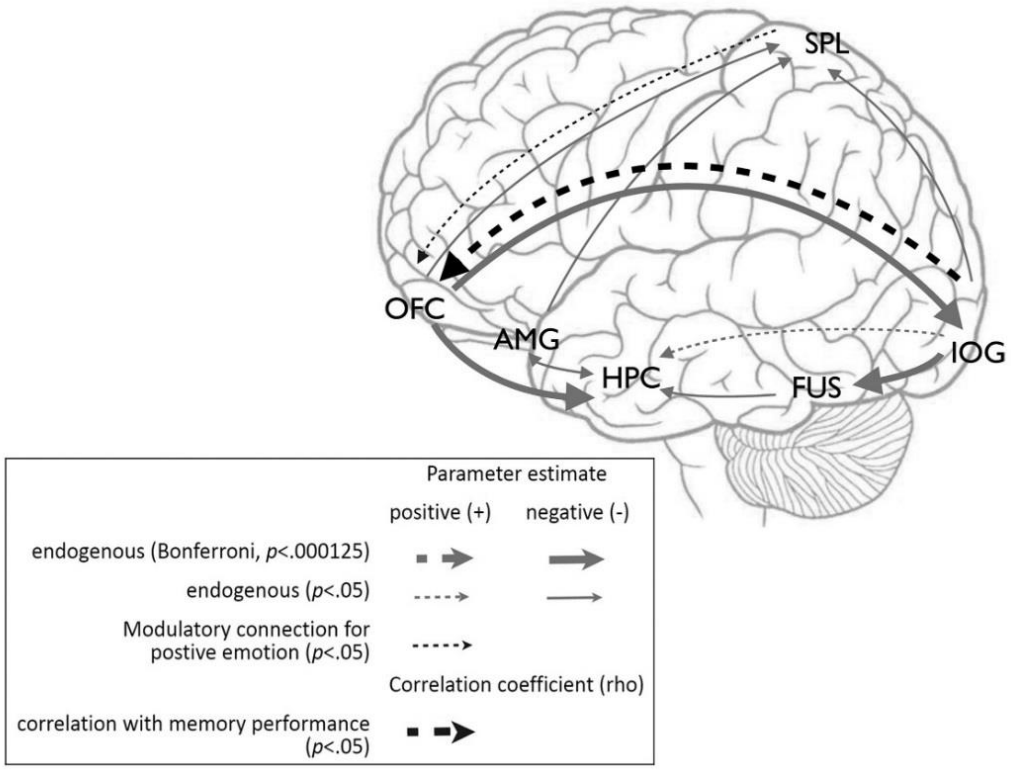

Figure 2. Ventral and dorsal neural pathways of emotional face processing

One question emerges: how do these neural pathways support the process-oriented emotion-memory interaction illustrated in Figure 1? It is assumed that the ventral pathways may provide bottom-up perceptions of situational information, with connections from the IOG to the fusiform gyrus (FUS) and the HPC supporting implicit process of facial information, and with the connectivity from the IOG to the OFC supporting explicit process. The dorsal pathway may provide a mechanism to drive emotional arousal: the connections between the IOG and the AMG to the SPL may function as a bottom-up process elicited by the saliency of emotional expressions, and the connectivity between the SPL and the OFC may serve the top-down process and thus can predict subsequent recognition behavior. Furthermore, does this brain network subordinate different levels of processing emotional information? For example, emotional face processing involves the perception of facial information, the identification and processing of specific emotional stimuli, and semantic and elaborative processing of emotional information (e.g. emotional evaluation). The finding in Study 1 suggests that the first and second levels may be associated with connections from the IOC and the SPL to the OFC, respectively. Emotional evaluation is suggested to be associated with the function within the frontal region. Although the

Study 1 did not identify the top-down modulations from the OFC on other information processing pathways (i.e. top-down models in Study 1), it is worthwhile in the future research to investigate whether these top-down modulation pathways can support the self-regulation as a function of the OFC.

4.1.2 Negative bias on emotional memory

One important behavioral characteristic of emotional influences on memory process found in the present thesis is a negative bias in recognition and retrieval processes.

First, a subsequent recognition memory test in Study 1 showed a higher response bias for the negative emotional faces than both positive and neutral ones. Nevertheless, Study 1 suggests that memory process and emotional process work in parallel during memory formation, and arousal-inducing response bias for negative faces relates to recognition operations rather than memory formation process. The findings of Study 1 emphasize the role of two bottom-up connections during emotional face processing: ICG→OFC and SPL→OFC connections, which may serve differentiated emotional influences on memory performance. First, the ICG→OFC that supports explicit visual attention and perception of facial information was found to be negatively correlated with successful recognition of old faces independent of emotional valence. Likewise, previous studies indicates that emotion exerts parallel effects on perception (Calder & Young, 2005), attention and memory (Talmi, 2013; Talmi *et al.*, 2008). One assumaption is that the parallel effect may work through the ICG→OFC pathway. By contrast, positive and negative stimulus showed different modulation effects on SPL→OFC connection, which was found to be associated with response bias for negative stimuli. These findings indicates that the negative bias in a subsequent recognition memory test may associate with the functional coupling between the SPL and the OFC.

Second, cross-cultural evidence in the Study 2 and Study 3 showed that negative bias could be observed in grief-related memory disruptions. Specifically, Study 2 found that negative emotional cues triggered a larger portion of loss-related memories than the positive cues. The associations between grief severity and memory disruptions such as reduced specificity and preferential access to loss-related memories was particularly noted in the response to negative cues. All these findings support the perspective that negative emotional stimuli enhance recollection experience. Second, consistent with the mood-congruent hypothesis, emotional states can elicit a negative bias in memory retrieval, for both Study 2 and Study 3 found that

bereaved individuals with more severe prolonged grief provided more loss-related memories in response to emotional cues or as a reference of self-identity. According to the hypothesis "failure to integrate loss-related memories", despite survivors' conscious avoidance of the negative affect (top-down modulation), loss-related memories remain active and vivid due to their emotional saliency, which are sensitive to negative arousal-inducing stimuli or emotional states (bottom-up saliency). Moreover, bereaved individuals manifest a tendency to endow loss-related memories with an importance for their life and self (top-down modulation).

Furthermore, the process-oriented perspective that highlights how emotion mobilizes mental and physical resource to affect memory performance through bottom-up and top-down processes provides a thorough understanding of the negative bias. Memory negative bias originates from affectively biased distribution of mental resource. Namely, emotional arousal has a function to drive biased effects in multiple processing including perception, attention, working memory, and memory encoding and retrieval. This perspective encourages an expansive exploration on the relationship among different cognitive processes. For example, rumination, a behavioral and cognitive tendency to focus one's attention on ones' symptoms and the implication of these symptoms, has been widely established as a crucial psychopathological process in the onset, maintenance and recurrence of depression, anxiety, posttraumatic stress disorder and prolonged grief disorder (Eisma *et al.*, 2013; Michael *et al.*, 2007). As rumination is a clinical manifestation of attention bias, it can be assumed that rumination may serve as a mediator between emotion arousal and memory process. The process-oriented perspective implicates at least two areas for future studies. First, both self-regulation and stimuli saliency can modulate rumination along two competitive processes. Second, studies that explore mediators can pay more attention to multiple components and channels, such as working memory and cognitive style at the psychological level, as well cortex activity and hormone releasing at the physiological level.

4.1.3 Grief-related disruptions in four dimensions of autobiographical memory

Autobiographical memories play a fundamental role in the maintenance and development of the self, which bridge the everyday experiences and personal meaning system. According to the model of reciprocal relationship between self and autobiographical memory (Wang & Conway, 2004), in a developmental or bottom-up route, everyday life events provide vivid and affective resources for autobiographical knowledge database. This develops into and maintains a

personal meaning system, such as sense of self, assumptive world, beliefs, life goals and purpose. Such a system acts as an orientation agent and serves as a basis for understanding and reacting to life-events (Gilles, 2015). Reversely, in a top-down route, preexisting personal meaning system can exert top-down modulations in the encoding and organization of autobiographical memories. From a clinical perspective, stressful life events such as the death of a love one can challenge, shatter or shift both systems, which manifest in grief-related alterations or disruptions in autobiographical memory.

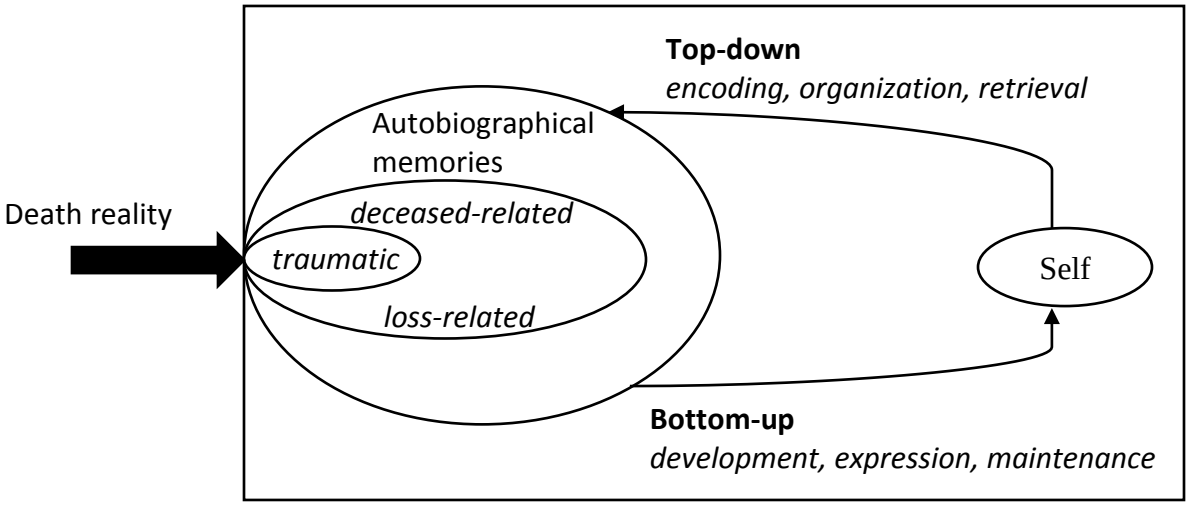

Figure 3. Reciprocal relationship between self and autobiographical memory in the context of grief, modified from Wang and Conway (2004)

The death reality causes intensive grief responses, such as being shocked by and disbelieving for the reality, sadness for the loss, and persistent yearning or longing for the deceased. All these emotional reactions influence the coherence and reorganization of autobiographical memory system, illustrated in Figure 4. Neimeyer et al. (2011) indicated that mourners' self-narratives are reaffirmed or reformulated over the course of grieving as they strive to process and accommodate both the "event story" of the death itself and the "back story" of the lives. The event story may give rise to traumatic memories, particularly in the aftermath an unexpected or traumatic death. The "back story" of the death encompasses memories related with the relationship with the deceased (e.g. shared memories with the deceased before his or her death), and loss-related memories that include memories of events that are associated with the individual's death or memories relating to an aspect of the grief experience. Poor or failed integration of loss-related and deceased-related memories, particularly the traumatic memories,

into autobiographical memory system can prolong and complicate individuals' grief responses (Boelen et al., 2006; Maccallum & Bryant, 2013). The Study 2 and Study 3 provide empirical evidence for this perspective in terms of bottom-up and top-down routes.

Because of the bottom-up saliency of loss-related memories, Study 2 showed pan-culturally characteristic that loss-related memories are preferential accessed and immune from overgeneralized process. In the top-down process, bereaved persons' emotion-regulation strategies (i.e. "functional avoidance of negative affect") presented a weaker effect and received moderations by culture. For example, in the Study 2, the reduced specificity was observed in the Chinese bereaved parents and Swiss parents with low traditional values, whereas the Swiss bereaved with high traditional values showed deliberate grief avoidance to report a larger proportion of specific non-loss-related memory for positive cues. Moreover, Study 3 indicates that personal meaning system may be reconfirmed or reconstructed over the grieving process. Consistent with mood-congruent hypothesis, one's cognitive process (e.g. self-evaluation narrative process in Study 3) gave more attention to stimulus events that were affectively congruent with their grief condition, which may elicit more intensive emotional arousal. As a result, grief severity was associated with disruptions in both memory retrieval and appraisal processes during memory narration: bereaved individuals exhibited a stronger preferential to use loss-related memories as central events for with severe prolonged grief, and made more maladaptive appraisals for their self-defining memories.

Overall, grief-related disruptions manifest in the four dimensions of autobiographical memory (Blagov & Singer, 2004): content (preferential retrieval of loss-related memories), specificity (relatively reduced specificity), emotionality (negative bias) and meaning (negative appraisals).

4.2 Cultural Considerations on Grief and Autobiographical Memory

4.2.1 The structure of culture

To understand the cultural effects on psychological process and behavioral performance, the fundamental question is "what is culture?" Within cross-cultural psychology, one major perspective considers culture to be a system of meaning that a group shares, whereas another major perspective conceptualizes culture as a set of shared conditions (e.g., ecology and sociopolitical environment) that individuals within that culture adapt to and internalize as individual-level attributes (Berry et al., 2002). Figure 5 describes the cultural living condition

and cultural meaning system at the macro and individual levels. At the macro level, cross-cultural psychology has a tradition to compare samples from different ethnicities, particularly Western and Eastern cultures, with an assumption that these macro groups manifest different moral stance and political philosophy (e.g. individualism vs. collectivism) and mainstream cultural values and beliefs (e.g. materialism, ethical orientation, religious orientation) that have developed and evolved along their own ecological-historical-social-political context (Fischer & Boer, 2016; Nisbett et al., 2001). At the individual level, personal situations are relevant to social conditions, and cultural meaning system projects into or cultivates the culture-related components within personal meaning system (e.g. personal value orientation, social beliefs, and world assumptions). This model indicates that the cultural effects can be investigated through cross-cultural comparison at the macro level, as well as through examining the moderation or mediation effects of cultural components at the individual level.

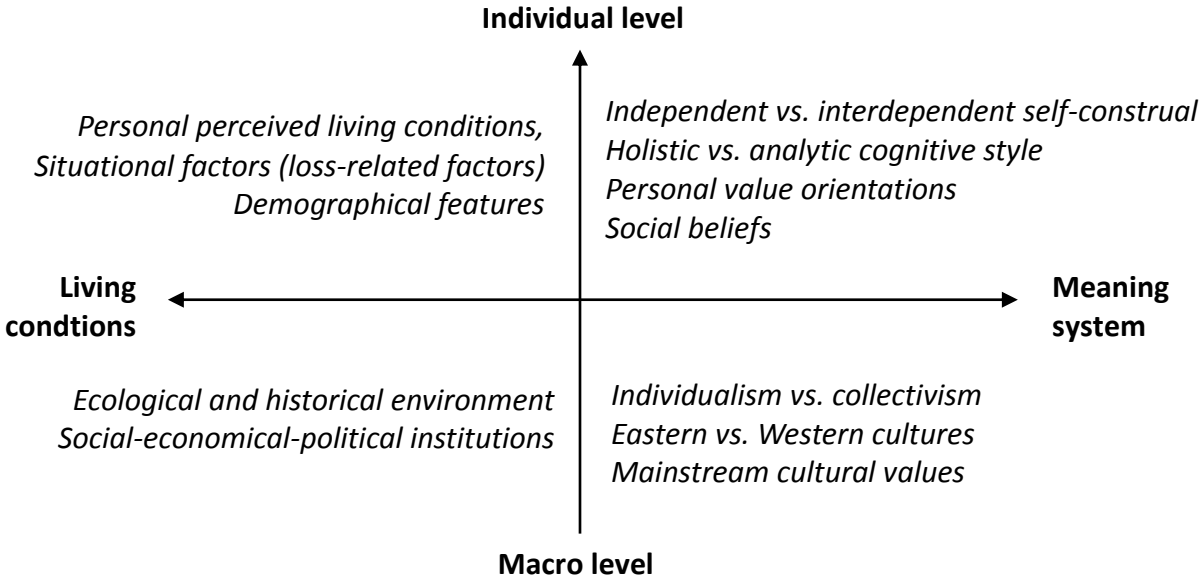

Figure 4. The structure of culture

In addition, according to the constructivism, the living condition is the situational environment that works as a background for emotional memory and self-regulation, while the culture-related components in personal meaning system function as important agents of self-regulation.

4.2.2 Cultural comparison of grief-related memory disruptions

Study 2 and 3 used Chinese and Swiss bereaved parents as representatives of the Western and Eastern samples, and investigated whether the psychopathological processes of grief-autobiographical memory interaction and their clinical expressions remain similar in different cultural contexts. First, culture differences were shown that bereaved Swiss parents provided a larger proportion of specific loss-related memory during autobiographical remembering than the Chinese, whereas Bereaved Chinese parents showed a tendency to elaborate their self-defining memories with positive meanings. Neither characteristic was associated with their symptom severity. Instead, these cultural differences have been attributed to the independent self of Swiss people, and holistic reasoning style in Chinese people. Specifically, the bereaved Swiss parents with an independent self tend to put a priority on the private internal aspects of self (Group, 1994), and thus focus on personal perceptions and their connection with the child. The independent self may result in an apparent preoccupation with increased levels of distress (Xiu et al., 2016). By contrast, Chinese people with a context-dependent and holistic tendency may have a preference to elaborate the meanings of life events, by the manners of finding the relationship between events, accepting the negative and positive aspects, and accumulating experience-based knowledge (Nisbett et al., 2001). These symptom-unrelated findings support the perspective that culture can affect what to remember and how to use the memory (Ross & Wang, 2010).

Moreover, pan-culturally manifestations were shown in the grief-related memory disruptions. In the Study 2, the competitive processes between the preoccupation with loss-related memories and the functional avoidance of negative affect have successfully interpreted the cultural similarities and differences in autobiographical remembering. Consistent with the hypothesis "the preoccupation of loss-related memories", grief severity was found to be associated with increased retrievals of loss-related memory in both a shallow and an elaborative autobiographical remembering; whereas loss-related memories was found to be immune from overgeneral process (i.e. no reduced specificity was found for loss-related memory in Study 2). Overgeneral process originates from a coping strategy "functional avoidance of negative affect", by which the bereaved can reduce the distress through narration of the memory details. Furthermore, according to "failure to integrate loss-related memory" hypothesis, Study 3 investigated "maladaptive cognitive appraisal" during meaning-making narration and found culturally similar manifestations among bereaved Chinese and Swiss parents. Taken together,

these findings suggest that grief-related psychopathological mechanisms in autobiographical memory system can be applied for bereaved persons from different cultures.

4.2.3 Moderation effects of cultural components

The manifestations of psychopathological mechanisms of the grief-memory relationship were found to be moderated by cultural background and cultural components. This thesis considered personal value orientations as a crucial marker of culture. The traditional and modern values are alternative assessment of interdependent-vs.-independent self-construal. As values have a cognitive function to evaluate the importance of events and a motivation function to guide one's behavior (Schwartz, 1992), they were assumed to be associated with coping strategies and cognitive process. Particularly, traditional values that stress collectivism, submissive self-restriction, preservation of traditional practice, protection, and stability have been found to be associated with both functional avoidance and negative appraisal. The Study 2 showed that Swiss people with high traditional values exhibited an avoidance of loss-related memory and diverted to specific memories related to positive emotions, when their grief was severe. The Study 3 found that the association between grief severity and negative appraisal of self-defining memories was remarkable when bereaved parents evaluated their traditional values, rather than modern values. In addition, as modern values are relevant to the independent self, people with high modern values may focus on personal perceptions and their connection with the child. The Study 3 thus found that parents with more severe prolonged grief tended to retrieve more loss-related memories in the response to modern values. However, the associations of prolonged grief severity with negative meanings was not as strong for modern value cues as for traditional values. As previously shown that modern values were associated with resilience and positive health (Maercker et al., 2015), these findings indicate that the modern values may facilitate the integration process of grief-related memories. Nevertheless, future studies should further investigate the role of modern values on coping strategies and personal growth benefited from stressful events.

Previous studies showed that the effect of personal value orientations to predict mental health was through the approach to mediating social sharing process of traumatic experiences (Maercker *et al.*, 2009; Müller *et al.*, 2011). This thesis further adds our information that personal value can be associated with cognitive process of traumatic memories in terms of narrative and meaning-making processes. The role of modern and traditional values would be

better clarified by examining one specific social and cultural background. In both Chinese and Swiss cultures, the death of child is against the expectations of a traditional culture that emphasizes the central family structure, stability, conformity with rules and social expectations. In a modern society, such as the materialism-pursuing China, bereaved persons must confront an uncertain situation in which their traumatic experiences and grieving process may be socially acknowledged or not (Klass, 2001). The potential conflicts may cause difficulties to reconstruct self-identity in social backgrounds, particular for bereaved Chinese parents who have strong social cynicism (negative beliefs about the human nature) (Xiu et al., 2016; Zheng & Lawson, 2015). Furthermore, as personal values are the manifestations of cultural meaning system (Schwartz, 2014), individuals develop and construct personal value orientations to some extent in accord with the expectations of their society and culture. Thus, the social acknowledgement could transform into self-acceptance, that is, a compassionate self-awareness that one's bereavement experience and own pains are understandable and legitimate as judged by existing values and beliefs system (Neimeyer & Cacciatore, 2015). In the Study 2, self-acceptance may play a role during the process of self-evaluation, in which individuals appraise their bereavement and life events aimed to reflect or clarify their self-identity in relation to personal value orientations. On the one hand, traditional customs provide some culture-specific ways to mourn the loss with familial and social supports (Rosenblatt, 2008). On the other hand, bereaved parents may experience challenges to their traditional values and feel unacceptable or unacknowledged, which can result in maladaptive appraisals and consequently be associated with severe prolonged grief in some bereaved parents. Therefore, the role of modern and traditional values might stem from the social acknowledgement and self-acceptance saturated in cultural backgrounds. However, the conceptualized self-acceptance needs a further investigation in future study as a potential mediator.

Taken together, the purpose to discuss the role of cultural background and cultural components is to emphasize the effects of environmental context and self-regulation in emotion-memory interaction. The moderation effects found in the present thesis indicate that emotional process, memory process, and their interaction are saturated in the cultural context, through the top-down modulation of self-regulation. Value orientation is an important agent that bridges self-regulation and macro cultural meaning system. As the Study 1 suggests that the dorsal neural

pathway may be a key candidate to execute the top-down process, it is worthwhile for future studies to investigate whether the alterations or dysfunctions in these brain connections are associated with grief-related disruptions in memory retrieval and meaning-making narration, furthermore whether culture can differentiate their patterns.

4.3 Practical Implications

4.3.1 Clinical interventions on autobiographical memory

The newly proposed process-oriented perspective on emotion-memory interaction may contribute to current understanding of the mechanisms underlying widely used interventions and psychotherapies that precede the disruptions in autobiographical memory following traumatic events. First, the bottom-up category refers to the clinical interventions that directly target the characteristic manifestations of memory, aimed to improve autobiographical memory specificity (Neshat-Doost *et al.*, 2012; Raes *et al.*, 2009; Williams *et al.*, 2000), intrusive memories and flashbacks (Brewin *et al.*, 2009; Holmes *et al.*, 2009), vividness recollection and negative valence (van den Hout *et al.*, 2011), memory structure (Gidron *et al.*, 2001), or autobiographical representations (Neuner *et al.*, 2008). The Study 1 may provide neural bases for this category of memory interventions. Specifically, as emotional process parallel to the memory process can modulate memory formation in a bottom-up fashion, memory interventions that function to decouple the connections between regions of emotional processing and memory consolidation may have a role to inhibit the formation of emotional memories. For example, Holmes *et al.* (2009) found that playing visuospatial computer game following traumatic events could reduce subsequent flashbacks. One plausible explanation is that this intervention task functioned as a bottom-up saliency to divert mental resource away from consolidating process of emotional memories. At the brain level, an enhancement of the IOG activity (during playing computer games) could inhibit the working of frontal cortex regions, which may interfere with memory formation, regardless of emotional valence.

The second category of clinical interventions is to address the top-down integration between memory and self-construal, such as cognitive intervention (Blairy *et al.*, 2008) and meaning-making narration (Neimeyer, 2000). Traditional bereavement theories have advocated that narrative disclosure of painful experiences is essential to the work of mourning. However, some empirical studies through cross-sectional and longitudinal designs found that neither induced nor naturally occurring disclosure was associated with better adjustment (Stroebe et al.,

2002), and that recounting negative thoughts and feelings early in the grief course predicted more severe persistent grief symptoms 2-year post loss (Capps & Bonanno, 2000). Recent research adds our understanding about how to design an effective narrative therapy. First, Baddeley and Singer (2009) argued that successful narrative disclosure should be saturated in social interaction. The social sharing of narratives is a key way of articulating and reinforcing life lessons that emerge from loss. Second, the study of Neimeyer (2005) indicates that the way in which narration contributes to bereavement care and adjustment of loss is through the quest of meaning. Elaborating narratives has been viewed as an approach to foster positive personal transformation (Neimeyer, 2004). Furthermore, the findings of the current thesis indicate that the (mal)adaptive outcomes rely on the valence of meanings found or made in ones' social and cultural context. The Study 3 showed that negative meaning predicted prolonged grief severity, whereas positive meaning was not associated with the effect to alleviate symptom severity. Although it needs a further exploration whether positive meaning of narration can facilitate posttraumatic growths as positive trauma outcomes, these findings suggest that cognitive reconstruction of negative meaning seems to be an important intervention to reduce symptom distress.

In addition, some psychotherapies attempted to merge both interventional approaches. For example, life-review therapy is a structured, integrative intervention that focuses on the whole-lifespan autobiographical memory, originally was developed in social gerontology. Maercker (2002) described three active principle of life-review therapy: (1) to promote the balance of positive and negative memories through enhancing the dominance of positive memory over negative ones; (2) to redefine negative experiences and find meaning from trauma; (3) to elaborate memory in greater detail. It remains an interest whether a narrative therapy concentrating on both bottom-up and top-down process can be adapted to other clinical groups with different age ranges or traumatic experiences.

As the process-oriented perspective emphasizes the interaction between emotional and memory processes, an integrative psychotherapy would pay more attention to the dynamic processing of emotion regulation and self-regulation during memory integration. First, a bereavement intervention that targets grief-related psychopathological mechanisms can utilize bottom-up methods to alleviate the preoccupation of traumatic memories, re-habitat their emotional regulation to decrease the functional avoidance of negative affect, and foster meaning-

oriented narrations aimed to transform "failure in integration of loss-related memories". Second, therapists should support and promote clients to reexamine, reaffirm and reconstruct their personal meaning system (e.g. personal identity, values, world assumptions) with a positive adaption to their community, social and cultural context. In addition, four dimensions can be used to evaluate and monitor the quality of autobiographical narration. The "specificity" dimension aims to elaborate memory in detail and enrich remembering experiences. A highlight is on the associations of these memories with their self-identity or personal meaning. The "content" dimension stresses the integration of traumatic memories into autobiographical knowledge base, through reducing intrusive memory and elaborating memory connections. The "emotionality" dimension means an enhancement of positive experiences (e.g. positive feelings, engagement in life, meaning) with a balance of negative memory. The "meaning" dimension emphasizes the importance of meaning found or made for the traumatic event, cognitive reconstruction of negative meaning, and personal growth related to meaning system.

4.3.2 Multiculturalism in psychotherapy

Multiculturalism in psychotherapy has been a major focus in the last decade. There are two concerned questions: can the clinical interventions and psychotherapies that have been developed in Western cultural context apply to clinical groups from a different culture? What therapeutic modality can be offered that is ecologically based on bereaved individuals' social and cultural circumstance? It is promising to find that grief-related psychopathological processes on autobiographical memory appears to override the Eastern and Western cultural backgrounds. This this provides a theoretical support for the development of grief psychotherapies and bereavement interventions with a cross-cultural validation. First, Xiu et al. (2016) found that Swiss and Chinese bereaved parents share a similar profile of prolonged grief disorders according to ICD-11, with cultural differences only being shown in the severity of certain symptoms. Furthermore, the Study 2 and 3 indicate that the psychopathological mechanisms in prolonged grief, such as the competitive processes of "preoccupation of loss-related memories" and "functional avoidance of negative affect" in memory retrieval, and "failure to integrate loss-related memories" in memory integration, can explain the cultural similarities and differences in the manifestations of grief-related disruptions in autobiographical memory system. These findings mean that grief interventions that focus on grieving processes of autobiographical

memory integration and meaning reconstruction may be theoretically advisable and effective for bereaved persons from different cultures.

The cultural differences shown in our series of studies may offer a guidance to develop culture-sensitive/adapted psychotherapies. For example, the bottom-up bereavement interventions that work on psychopathological characteristics of autobiographical memory may be effective for the Western bereaved individuals, as a cross-cultural comparison showed that bereaved Swiss parents exhibited more intensive symptom severity in the preoccupation of the memories related to the deceased (Study 2). While top-down bereavement interventions that facilitate cognitive reconstruction and meaning making may be culturally adaptable for the Eastern bereaved individuals, as the bereaved Chinese parents suffered from more severe functional impairment and accessory grief symptoms such as feeling life is empty and meaningless (Xiu et al., 2016). In addition, due to the holistic style of reasoning, Chinese people have a tendency towards elaborated narrations with positive appraisals to reflect their experiences in terms of broader context and general meaning. One question is whether this tendency is a mental resource that can be utilized by narrative therapy to facilitate their meaning-making process.

In addition, one culture-based intervention could address value orientations. First, when a negative event is construed as central to one's identity and life story, it causes a reexamination of values and beliefs. Thus, it would be helpful to assign an intervention to assist bereaved persons to clarify and rebuild a value system. Second, Study 3 suggests that the discrepancy or conflict between personal traditional values and the mainstream cultural values in the modern life may complicate the grieving process and cause maladaptive consequences. An intervention that addresses the conflicts in traditional values may be beneficial for their self-acceptance and perception of social supports, and play a role to modulate maladaptive appraisals during their meaning reconstruction. Therefore, one practical implication could be to facilitate narrations of grieving clients to reconstruct their negative appraisals that center on traditional values in relation to the hardship of the personal loss.

4.4 Limitations

Theoretically, although the current thesis attempted to integrate studies on emotional memories in line with the theoretical framework of bottom-up and top-down processes, the relationship among different components needs further clarification and extensive investigations.

For example, the present thesis integrates the views of self-regulation and emotion-regulation into the process of top-down modulation, as two processes are relevant to goal-related contexts (Diamond & Aspinwall, 2003). Whereas self-regulation is typically conceptualized as involving the control, direction and correction of one's own actions in the process of moving toward or away from various goals (Carver & Scheier, 1990), emotion regulation focuses on how emotion-related experiences are modulated through internal and transactional processes (Ross, 2007). Emotion regulation may leave the goal-related context of emotional experience unspecified. In addition, it has not clearly identified the differences between emotion-bias and mood-bias effects. Although mood is considered as an emotional state that last longer than emotions, compared with mood, emotion typically have specific objects and give rise to behavioral response tendencies to these objects (Gross & Thompson, 2007). In compared with emotion-regulation, mood regulation and mood repair are more concerned with altering emotion experiences than emotion behavior (Larsen, 2000). Nevertheless, the current thesis assumed that both emotion- and mood-bias in memory performance operated similar processes that events saliency or goal-modulation elicit psychophysiological arousal to mobilize mental and physical resource.

There are some limitations in the study design. First, Study 1 showed the overwhelming effect of bottom-up models by investigating the process at the group level. When identifying the prioritized model at the individual level, several participants adopted one of the top-down models with a highest exceedance probability. The finding indicate the individual differences in emotional facing processing, which should be further investigated in the future study. Second, the clinical studies utilized a cross-section design, which cannot clarify the reciprocal relationship between grief responses, memory disruptions and modulation of personal values. For example, it was assumed that bereavement threatens the personal meaning system and gives rise to some traumatic or loss-related memories that are emotion-laden and difficult to be integrated. However, it is therefore difficult to draw a conclusion about whether prolonged grief results in disruptions of autobiographical memory or the non-integrated self-memory system maintains or complicates the grief reaction.

Moreover, the sampling strategy restricts the application of the findings. To guarantee the homogeneity of participants and avoid some uncontrollable factors, the neuroscience study only included healthy young male adults and the clinical studies focused on bereaved parents with inclusion and exclusion criteria in recruitment. First, it needs to be resolved whether our main

results in the neural study can be replicated in different samples, such as females, different age groups, or clinical samples for which similar networks were implicated. Second, the application of the clinical findings should be taken in caution. For example, in the clinical studies, the majority of Chinese participants are parents who lost their only child. As China previously had the "One-child policy", the unique historical and social background may complicate the grieving process and lead to cultural difference due to the institutional system. In addition, the clinical studies have revealed the associations between PG severity and autobiographical remembering, indicating that grief-related disruptions of memory manifestations can be observed in bereaved individuals with variations in the level of memory alteration. However, it is uncertain to what extent the observed finding are because no formal diagnosis evaluation take place. It would be interesting for further research to retest these results in bereaved individuals meeting criteria for a diagnosis of prolonged grief disorder.

4.5 General Conclusion

The present thesis proposes an integrative perspective that facilitates the current understanding on the relationship between emotion and memory. First, this thesis revealed the neural basis for dominate bottom-up mechanism during memory formation, competing with top-down modulation, which preceded emotion and memory process in parallel through ventral and dorsal neural pathways. Second, the process-oriented theoretical framework was successfully to assist investigations on grief-related memory disruptions in relation to the competitive processes between bottom-up saliency (i.e. preoccupation of loss-related memories) and top-down modulation (i.e. functional avoidance of negative affect and maladaptive cognitive appraisal). The second research displayed psychopathological manifestations of prolonged grief in four dimensions of autobiographical memory, which were moderated by cultural background and personal value orientations. Finally, this thesis encouraged to integrate clinical interventions on emotional memory. Clinical attentions should be drawn to the role of culture at both macro and individual levels, in order to guarantee the cross-cultural validation of psychotherapy.

5. PUBLICATIONS

5.1 Study 1: "*Emotional face expression modulates occipital-frontal effective connectivity during memory formation in a bottom-up fashion*"

Daiming Xiu, Maximilian J. Geiger, Peter Klaver

(A similar version of this manuscript has been published in *Frontiers in Behavioral Neuroscience*)

5.1.1 Abstract

This study investigated the role of bottom-up and top-down neural mechanisms in the processing of emotional face expression during memory formation. Functional brain imaging data was acquired during incidental learning of positive ("happy"), neutral and negative ("angry") faces. Dynamic Causal Modeling (DCM) was applied on the fMRI data to characterize effective connectivity within a brain network involving face perception (inferior occipital gyrus and fusiform gyrus) and successful memory formation related areas (hippocampus, superior parietal lobule, amygdala and orbitofrontal cortex). The bottom-up models assumed processing of emotional face expression along feed forward pathways to the orbitofrontal cortex. The top-down models assumed that the orbitofrontal cortex processed emotional valence and mediated connections to the hippocampus. A subsequent recognition memory test showed an effect of negative emotion on the response bias, but not on memory performance. Our DCM findings showed that the bottom-up model family of effective connectivity best explained the data across all subjects and specified that emotion affected most bottom-up connections to the orbitofrontal cortex, especially from the occipital visual cortex and superior parietal lobule. Of those pathways to the orbitofrontal cortex, the connection from the inferior occipital gyrus correlated with memory performance independently of valence. We suggest that bottom-up neural mechanisms support effects of emotional face expression and memory formation in a parallel and partially overlapping fashion.

Key words: dynamic causal modeling, fMRI, facial affect, memory formation

5.1.2 Introduction

It is well established that emotional stimuli can enhance learning (Hamann, 2001; Roozendaal and McGaugh, 2011). This enhancement has been attributed to initial encoding (Murty et al., 2010), memory consolidation (McGaugh, 2004), and retrieval processes (Sharot et

al., 2004; Dolcos et al., 2005). In addition to neural interactions between the amygdala and the medial temporal lobe memory system playing a pivotal role in these processes (Dolcos et al., 2004b; LaBar and Cabeza, 2006; Smith et al., 2006; Ritchey et al., 2008), there is now increasing evidence for other neural regions contributing to the initial memory formation of emotional memories in a bottom-up and top-down manner (Dolcos et al., 2004a; Kensinger and Corkin, 2004; Mickley and Kensinger, 2008; Mather and Sutherland, 2011; Ritchey et al., 2011).

First, emotional stimuli can capture attention that facilitates participation of multiple regions during perception (Vuilleumier, 2007; Pessoa and Adolphs, 2010). Some of these pathways may initially bypass the amygdala and indirectly contribute to emotional memory (Kensinger and Corkin, 2004; Sergerie et al., 2005). For example, functional connectivity studies reported that emotional stimuli modulate neural activity along parallel forward pathways from visual regions to the frontal cortex, which suggests that emotional face expression facilitates perception in a bottom-up fashion. These studies do not support a mediating role of the amygdala in perception of emotional faces (Fairhall and Ishai, 2007; Dima et al., 2011). Secondly, the frontal cortex encompasses different regions that contribute to emotional memory (LaBar and Cabeza, 2006). For example, top-down connections from the orbitofrontal cortex, a region implicated in the representation of affective value, reward and behavioral guidance, have a pivotal role in emotion-mediated learning (Rolls et al., 1994; Kumfor et al., 2013). Thus, while the amygdala plays a key role in rapid detection of facial affect through implicit processing (Hariri et al., 2003; Fitzgerald et al., 2006), the prefrontal cortex exerts semantic or elaborative processing via mechanisms of selective attention (Armony and Dolan, 2002). The orbitofrontal cortex not only modulates the connectivity between the amygdala and hippocampus during retrieval of emotional stimuli (Smith et al., 2006), but also constitutes a direct network with the hippocampus that mediates processing of positive emotional stimuli and increased feelings of familiarity (Mickley and Kensinger, 2008). Therefore, bottom-up activity to the orbitofrontal cortex and top-down elaborative processing of affective value in the orbitofrontal cortex on connections to the hippocampus might play important roles in the formation of emotional memories. It is however, unclear how multiple regions collaborate to support one of the two fashions and predict successful memory formation.

It should also be noted that the assumption of an automatic memory enhancement by emotional stimuli may be too simple (Bennion et al., 2013). Emotional stimuli can enhance both

recall accuracy and subjective feelings of recollection (Phelps and Sharot, 2008). In conditions exerting low distinctiveness (and high inter-item relatedness) between old and new items, it was often observed that an elevation of the number of correctly identified old items was accompanied by an increase in the number of incorrect identifications of new or related items (i.e. false alarms/false memories), which means that emotional stimuli can change the response bias without improving memory performance (Dougal and Rotello, 2007; Brainerd et al., 2008).This emotion-induced recognition bias might reflect flexible criterion setting triggered by emotional valence that works to ensure that emotional stimuli are not missed or considered irrelevant (Windmann and Kutas, 2001). The emotion-induced recognition bias is less evident during conscious retrieval than during familiarity-based recognition operations (Ochsner, 2000; Johansson et al., 2004), suggesting that top-down processes play a role in rejecting emotion induced false memories. More so, for stimuli with positive affect the role of top-down processing in memory may be even more important as memories of positive stimuli depend more on gist and attention related mechanisms (Talmi et al., 2007; Mickley and Kensinger, 2008; Talmi et al., 2008; Mickley Steinmetz and Kensinger, 2009). Hence, when studying neural mechanisms of emotional memory, we need to take into account that emotionally valenced stimuli can influence both memory performance and response bias.

The present study utilized Dynamic Causal Modeling (DCM) of functional magnetic resonance imaging (fMRI) (Friston et al., 2003) in an incidental learning task of faces with positive ("happy"), neutral and negative ("angry" or "fear") emotional expressions. Our first aim was to evaluate whether bottom-up or top-down models best explain variations in neural activity during memory formation of emotional faces. Effective neural networks were characterized to elucidate the effect of emotional face expression on memory formation. In bottom-up models we hypothesized that faces with emotional expressions would engage neural pathways in a bottom-up manner to the frontal cortex (Kensinger and Corkin, 2004; Talmi et al., 2008; Dima et al., 2011). In top-down models the frontal cortex would receive stimuli with positive and negative expressions and then modulate connections to the hippocampus (Sergerie et al., 2005; Smith et al., 2006; Mickley Steinmetz and Kensinger, 2009; Ritchey et al., 2011). The best fitting model across subjects was selected and connectivity strengths were utilized to predict memory performance and response bias. Since bottom-up processes are important in perception of emotional faces (Fairhall and Ishai, 2007; Dima et al., 2011) and episodic memory formation

(Dickerson et al., 2007; Sepulcre et al., 2008), we expect that the bottom-up model best explains memory formation of emotional faces. Our second aim was to examine whether pathways involved in emotional face processing directly contribute to memory performance. Based on the role of frontal and visual areas in memory formation and emotional face processing, we expect that pathways between these areas be involved in both these processes.

5.1.3 Methods

Eighteen healthy male adults (age 18-35 years old, mean = 27.6 years, SD = 5.1) without psychiatric or neurological disorders were recruited through advertisement at the university campus (University of Zurich). All subjects were German speakers, with 33.3% Swiss German speakers. They provided written informed consent and received payment for their participation. The study was in accordance with the guidelines of the local ethics review board of the Canton of Zurich.

Experimental procedure

This study investigated the influence of face expression (negative, positive and neutral) on memory formation in an incidental-learning paradigm. Ratings on emotional valence and attractiveness were used to select the most and least attractive pictures respectively for both male and female faces with positive ("happy"), negative ("angry") and neutral expressions (Rimmele et al., 2009, Dinkelacker et al, 2011) (examples are shown in Figure 6). The pictures of faces were an assembly from different databases: NimStim Face Stimulus set (www.macbrain.org), Karolinska Directed Emotional Faces database (KDEF; www.emotionlab.se/resources/kdef) and freely available photographers pictures (www.photo.net) were formatted to a uniform standard (greyscale pictures of adult faces with direct eye contact, cut in an ellipsoid shape on a black background; hair, glasses, beard were allowed, but approximately equally distributed across emotional valence) (Dinkelacker et al. 2011). The negative faces had angry and fearful expressions; the positive faces had happy expressions. These pictures were rated independently on a 9-point Likert scale and classified according to the valence rating (n = 30) in a previous study (Dinkelacker et al. 2011). The same set was also used and rated independently by Rimmele et al. (2009). This resulted in 148 faces. We added a small number of faces (20) from the Radboud Face Database with negative valence after formatting them into the same uniform standard. That database is a set of validated faces for positive, neutral and negative emotional expressions (Langner et al. 2010). Thus, the reported studies that validated these stimuli showed

that on average there is a clear distinction between the valence of faces within the categories of face expression (positive, negative and neutral). In three separate fMRI runs, subjects were presented with randomly intermixed 112 gray-scale faces of different attractiveness, valence and gender. Each face was displayed for 3.5 seconds in the center of the screen. Inter-stimulus intervals varied between 2 and 18 seconds during which a fixation cross was shown. The tasks of the subjects was to judge "how much would you like to approach this person, if you encountered this person on the road?" and rank this judgment on a 6-point scale (from "very willingly" to "very reluctantly"). For half of the subjects the buttons were ranked "1, 2, 3" for the left and "4, 5, 6" for the right hand. To minimize left/right side effects, the other half of the subjects used a reversed ranking order. Subjects were instructed to think decision and to press the button when the fixation cross appeared. Subjects were not informed that this task would be followed by a memory test (Grady et al., 2002). Forty minutes after the study phase subjects completed a surprise recognition memory test outside the scanner in which 112 studies faces were intermixed with 56 new faces. For each face subjects were required to indicate by button press whether it was old or new on a 6-point confidence scale (two response pads each with 3 buttons each ranging from "sure old" to "sure new").

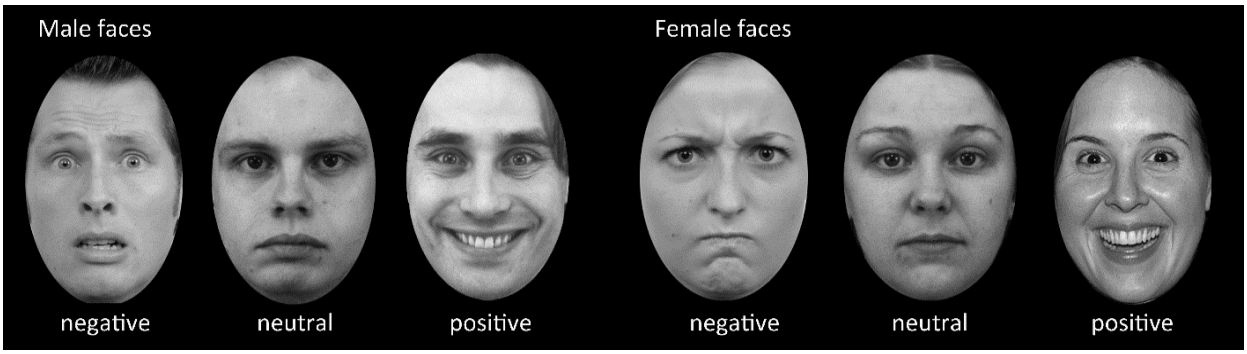

Figure 5. Example stimuli used in the incidental-learning paradigm and recognition memory test. In the learning phase, the subjects was asked to judge "how much would you like to approach this person, if you encountered this person on the road?" by a 6-point scale. The pictures of faces are from different databases such as the NimStim, Karolinska and Radboud database.

Behavioral analysis

This study only included the behavioral reactions to old and new faces without considering confidence level. We tested if confidence predicted memory performance or response bias, but found no significant interaction between confidence level and emotion on memory performance or response bias ($F[4, 48] < 1$, $p > .4$). This justified collapsing across confidence levels and allowed us to increase statistical power. Specifically, hit rate denoted the correct recognition proportion of studied faces for which subjects reported "sure old", "rather old" or "unsure old". False alarm rate denoted the proportion of unstudied faces for which subjects incorrectly responded "sure old", "rather old" or "unsure old". Hit rate and false alarm rate was calculated for each face expression separately. Faces that did not yield a response were excluded from the analysis. Memory performance (Pr = *p* [hit rate – false alarm rate]) and response bias (Br = *p* [false alarm rate / (1 – (hit rate – false alarm rate))]) were assessed according to the two-high-threshold theory (Snodgrass and Corwin, 1988). These scores were separately calculated for faces with positive, negative and neutral expressions. Statistical analysis on behavioral data relied on a repeated measures ANOVA with face expression as factor (positive, neutral, negative). Greenhouse-Geisser corrections were applied on degrees of freedom whenever sphericity assumptions were violated. All statistical analyses were performed using SPSS 19.

Brain imaging acquisition

Magnetic resonance imaging data were acquired on a General Electric Signa Excite 3.0 T whole-body scanner at the Center for MR Research of the University Children's Hospital Zurich. For fMRI three series of 159 scans sensitive to BOLD contrast with 44 axial slices covering the whole brain were acquired with a T2*-sensitive multi-slice echo planar imaging (EPI) sequence (repetition time = 2.4 s; echo time = 32 ms; field of view = 240 cm; image matrix = 64×64; voxel size = 3.75×3.75×3.50 mm^3; flip angle = 80°). The first 4 scans were discarded to allow for equilibration effects. Other scans were acquired that are beyond the scope of this paper.

fMRI analysis

Preprocessing

Data were analyzed using SPM12b (http://www.fil.ion.ucl.ac.uk/spm/software/spm12). All volumes were slice time corrected, realigned to the first volume, corrected for motion artifacts using the ArtRepair-toolbox that detected and corrected volumes for which the signal deviated more than 3 standard deviations or 1mm movement per TR (Mazaika et al., 2007), normalized

into standard stereotactic space using MNI template and smoothed with a 9 mm full-width at half maximum Gaussian kernel.

First level analysis

For each subject, we concatenated the data from three sessions and constructed a general model according to the emotional valences, where vector onsets represented negative, positive and neutral face expressions. This model was used for the DCM analysis. In addition, a separate general linear model was modeled to define volumes of interest. This model evaluated the subsequent memory effects and was based on the recognition test. Vector onsets represented remembered faces (participants pressed "sure old", "rather old" or "unsure old" on old items) and forgotten faces (participants pressed "sure new", "rather new" or "unsure new" on old items). The subsequent memory effect was identified from the contrast "remembered faces minus forgotten faces", and the face perception effect with all facial stimuli was identified by activity to both remembered and forgotten faces compared with baseline. Faces that yielded no responses during the recognition memory test entered the model as a regressor of no interest. All onsets of two models were convolved with a hemodynamic response function and a high-pass filter (128s) was applied to remove low-frequency noise. Outlier parameters from the realignment procedure of the artifact-repaired data were used as covariates in the design matrix.

Volumes of interest

We selected priori regions of interest at the second level. Random-effects analyses of the single-subject contrast images for subsequent memory effect model were used to identify regions related to face perception (family-wise correction $p < 0.05$) and successful memory formation (subsequent memory effect: $p < .001$, uncorrected) at the group level. Due to the robust effect in left hippocampus, we limited our regions of interest to the left hemisphere, which was also motivated by Smith et al. (2006). As a result, face perception related regions included the inferior occipital gyrus (IOG: x = -40, y = -78, z = -10) and fusiform gyrus (FUS: x = -36, y = -52, z = -10). A subsequent memory effect was found in several limbic and non-limbic regions (Table 1). We restricted the DCM analysis to two limbic areas (hippocampus (HPC): x = -30, y = -18, z = -14 and amygdala (AMG): x = -26, y = 2, z = -24), and two non-limbic areas related to attention and emotion processing (superior parietal lobule (SPL): x = -14, y = -68, z = 66 and orbital frontal cortex (OFC): x = 0, y = 62, z = -18). The HPC, AMG and OFC were expected. We also included the SPL, because this region was considered to be involved in visual-spatial attention

and may support both memory and emotion. For each subject, six volumes of interest (VOIs) used for the DCM analysis were defined as 4 mm spheres at the center of the nearest local maximum of group maximum, within the same anatomical area (information about centers of VOI for each subjects in Table 3). The time series of each VOIs were extracted by using Eigenvariates of SPM12b separately using the emotion model.

Table 1.Brain regions related to successful memory formation based on the contrast between studied faces subsequently correctly recognized as old (hits) > studied faces subsequently identified as new (misses).

Region (AAL)	Lobe	L/R	Peak Coordinates			Cluster size	T-values	Extend threshold (FDR)
			x	y	z			
Parahippocampal g.	Limbic	L	-18	-26	-20	47	4.23	.09
Parahippocampal g. / Amygdala	Limbic	R	22	2	-24	87	5.34	
Amygdala (AMG)	Limbic	L	-26	2	-24	13	4.88	
Hippocampus (HPC)	Limbic	L	-30	-18	-14	12	4.31	
Posterior cingulate g.	Limbic	R	4	-44	6	153	4.81	.025
Superior parietal lobule (SPL) / Precuneus	Parietal	L	-14	-68	66	148	5.77	.025
Orbital frontal cortex (OFC) / Rectus g.	Frontal	R/L	0	62	-18	111	5.53	.053
Cerebellum 9/Medulla	Cerebellum	R/L	8	-40	-52	282	6.14	.003

Note: Results are reported at a height threshold of $p < .001$, uncorrected. Areas outside the limbic lobe are reported only when they survived or showed a trend after cluster extent correction (FDR $p < .05$). Regions are listed based on the largest AAL cluster according to the *xjview* toolbox. Abbreviations: gyrus, g.

Dynamic causal modeling

Model specification

Dynamic causal modeling identifies dynamic and nonlinear systems in the brain that capture dependencies of brain regions over time and considers their interactions between inputs

and neural activity (Friston et al., 2003). We used the emotion model in order to clarify the emotional effects on connectivities. Assuming that emotional valence mediated propagation of face processing during encoding, an initial model for all subjects included bidirectional endogenous connections between all six regions and a main effect of "all faces" as the driving input entering the visual region, IOG. According to our hypotheses, this model was differentiated into bottom-up (BU) and top-down (TD) family models (Figure 7). BU family models indicate that emotion (negative and positive valences) modulated parallel forward pathways to the OFC during encoding. Emotion can influence one or more pathways from the IOG, FUS, SPL, HPC and AMG to the OFC, which contributed to 27 bilinear models. TD family models depicted that emotion influenced the modulatory effect of the OFC on one or more connections with the hippocampus. That is, the emotional stimuli (positive and negative faces) were directly processed in the OFC. The OFC then modulated one or multiple connections from the IOG, FUS, SPL and AMG to the HPC. The TD model family consisted of 15 nonlinear models. Details about model specification are shown in Table 4. To sum up, we produced 42 variants of DCM models with 30 endogenous connections representing the functional coupling between each of the six regions. Modulatory effects consisted of five emotional effects in the bottom-up family (facial affect on connections from IOG, FUS, SPL, HPC and AMG to OFC) and four effects of the OFC in the top-down family (the modulation from OFC on the connections from IOG, FUS, SPL and AMG to HPC).

Model comparison

DCM can utilize family level inference and Bayesian model averaging to select the model families and estimate the effective connectivities of optimal model(s) within families (Friston et al., 2003; Penny et al., 2010). Crucially, family inferences allow a large number of models to compare and provide more than one model as overwhelming winner. Family comparison and model selection was implemented using random-effects (RFX) Bayesian model selection (BMS) in SPM12b (Stephan et al., 2009; Penny et al., 2010). Two indices, the expected and exceedance probabilities, which were computed from the posterior densities over 42 models, denoted the level of confidence with which a given model outperformed any other model tested. In family inferences, the winner was selected between the BU family and TD family. Family level posteriors are a summation of model level posteriors over family members. Furthermore, in order to investigate whether the effective connectivities supported the memory formation, we applied

the random effects of Bayesian model averaging (BMA) to acquire subjects' connectivity estimates across all models based on the group winning family (Penny et al., 2010). We then used Spearman correlations to evaluate associations between behavioral measures (memory performance and response bias) and parameters for endogenous connections and modulatory effects of emotion on connections in the winning family. Since we were interested only in the connections that were relevant for emotion processing we tested only those endogenous connections in the winning family that connect to the OFC in the BU model family, respectively to the HPC in the TD model family and applied *Bonferroni* correction accordingly.

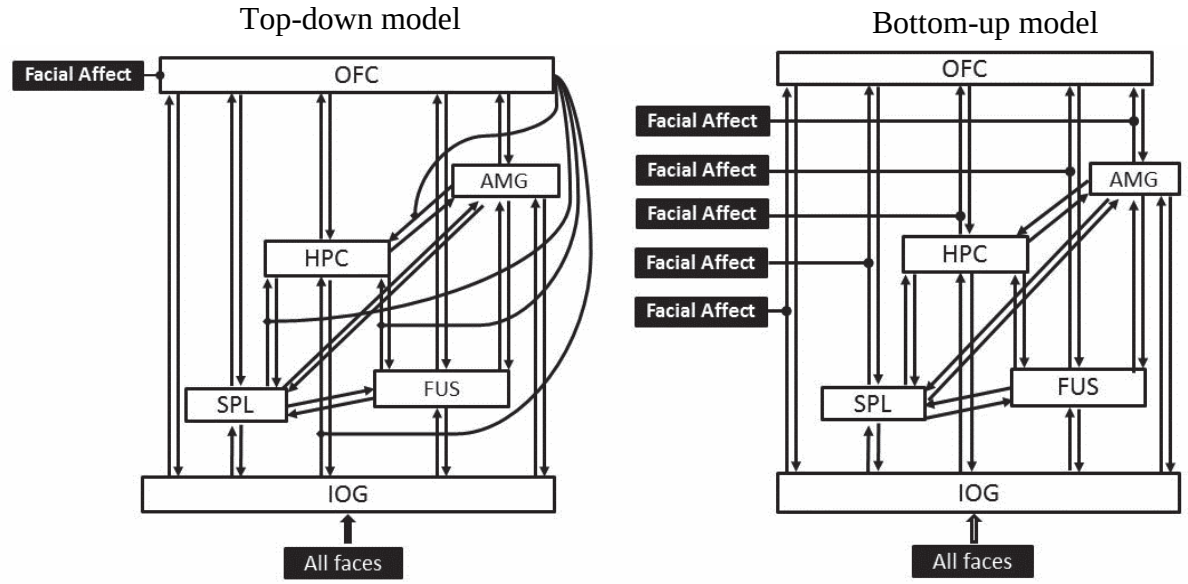

Figure 6. Concept models for the effective connectivity and emotional modulations within a memory-related network during learning in terms of the top-down and bottom-up approaches. Schematically, inputs of "all faces" are in visual region IOG; the modulations of facial affects correspond to negative and positive facial expressions. Model specification was based on these two concept models with one or several modulatory pathways (see in Table 4). Each one of 27 bottom-up family models had one to five bottom-up pathways that received stimuli from affective faces; all 15 top-down family models processed affective faces in OFC, but each one of top-down models received 1 to 4 modulations from OFC.

5.1.4 Results

Behavioral results

For the behavioral analysis, we calculated effects of emotion on memory performance for each expression separately (Pr = HR – FR) and response bias (Br = FR/ (1- (HR-FR)) (HR: hit rate, FR: false alarm rate). Memory performance and response bias for total and for each emotional face expression separately were significantly larger than 0 (all $p < .05$). A repeated measures ANOVA showed no effect of face expression on memory performance (F (2, 34) = 1.05, $p = .36$, $\eta^2 = .058$), but response bias was significantly different between emotional faces (F (2, 34) = 6.13, $p = .005$, $\eta^2 = .265$). The response bias was higher for negative faces than neutral (t (17) = 2.18, $p = .044$, effect size $r = 0.323$) and positive faces (t (17) = 3.13, $p = .006$, effect size $r = 0.379$) (Figure 8).

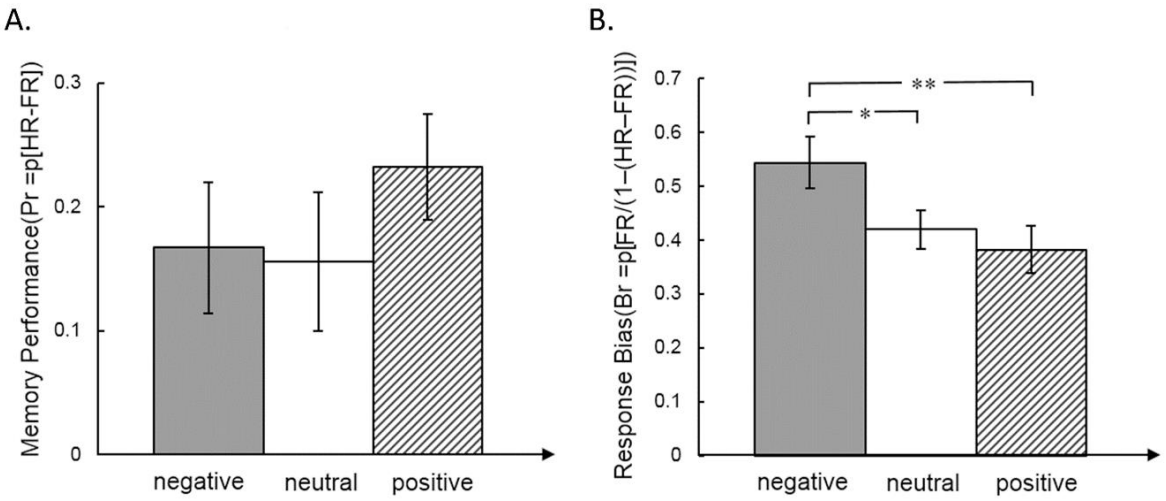

Figure 7. Memory performance and response bias measures for emotional valences. Post-hoc *t*-tests indicated differences between emotional face expressions in each group. *$p < .05$; **$p < .01$.

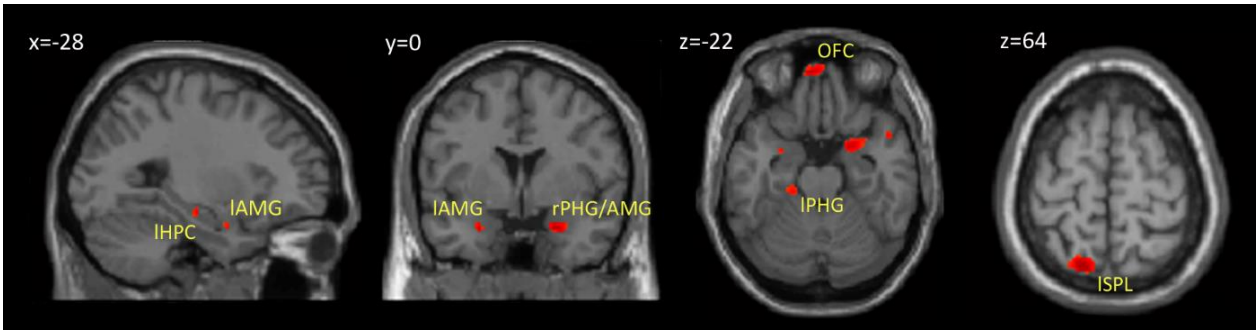

Figure 8. Brain regions showing a subsequent memory effect. The figure shows the results from contrast between subsequently recognized faces (hits) and subsequently forgotten faces (misses) ($p < .001$, uncorrected). Abbreviations are listed in Table 1.

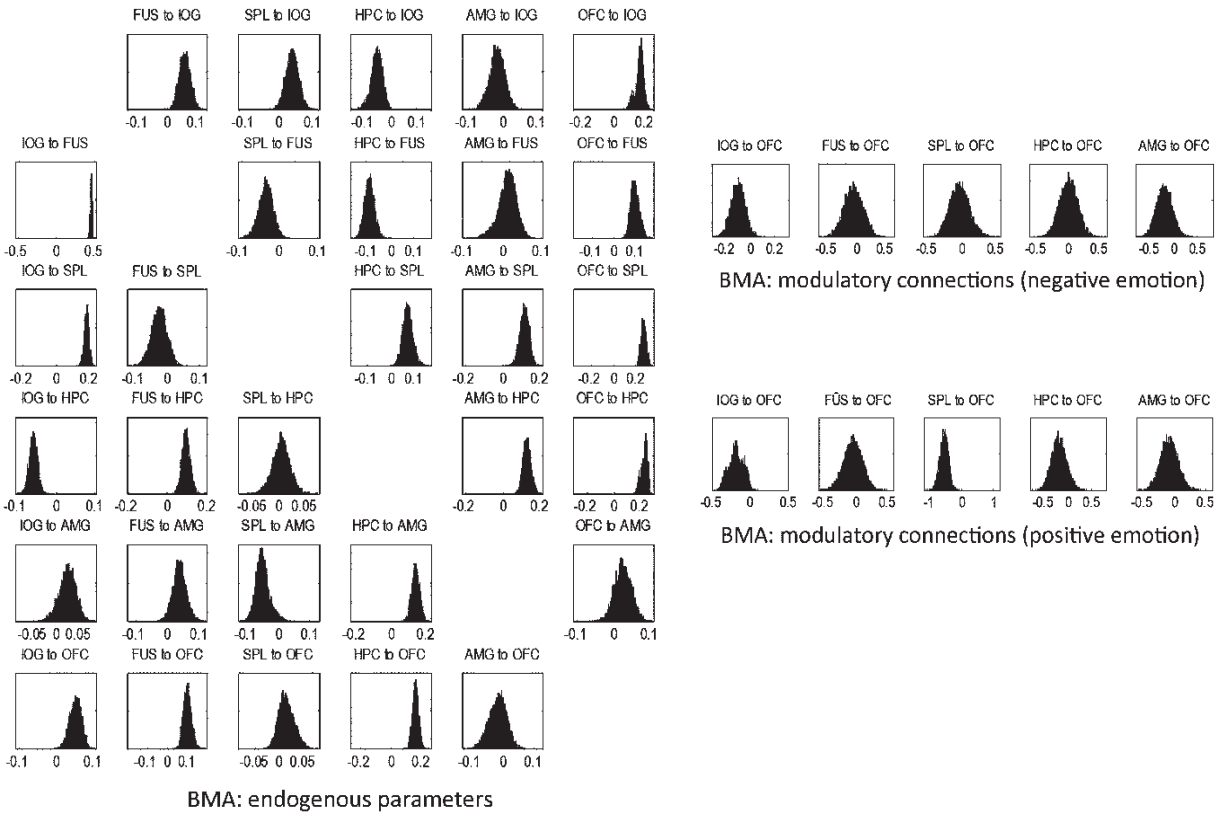

Figure 9. The posterior densities of average network parameters from random effects Bayesian model averaging for endogenous connections (left) and modulatory connections for negative and positive emotional faces respectively (right).

Subsequent memory effect

Within our neuroimaging data, we found a subsequent memory effect in several limbic and non-limbic areas. Limbic areas included the left hippocampus, bilateral amygdalae, left parahippocampal gyrus and posterior cingulate gyrus. Activity outside the limbic cortex was found in the posterior cerebellum, left superior parietal lobule and medial frontal cortex including the rectus gyrus and orbital frontal gyrus. Details are provided in Table 1 and Figure 8.

Family comparison and model selection

First, we executed the family comparison between bottom-up models family (totally 27 models) and top-down models family (totally 15 models). The BU family models were superior to the TD family with an exceedance probability of 99.3% across all subjects. Comparing the individual 42 models, Model 25 with the highest exceedance probability of 48.1% indicated that emotion affected all pathways to the OFC except the pathway from the FUS to the OFC (Model

25 in Table 4). The second-best model, Model 24, with 19.7% exceedance probability and Model 16 with 13.8% exceedance probability indicated that the connections from AMG and HPC to OFC received weaker affective effects than IOG and SPL to OFC.

We then used the random effects of Bayesian model averaging (BMA) to acquire subjects' connectivity estimates for endogenous and modulatory parameters. The Figure 10 shows the posterior densities of average network parameters from random effects Bayesian model averaging. Of the bottom-up pathways, the IOG, FUS and HPC had positive endogenous connections to the OFC. Within them, IOG→OFC received negative modulations from both negative and positive emotional expressions (modulatory parameter for negative expression: Median = -0.096, 25% quartile = -0.499, 75% quartile = 0.583; for positive expressions: Median = -0.095, 25% quartile = -0.578, 75% quartile = 0.259). The connection SPL→OFC received negative modulations from positive emotional expressions (Median = -0.450, 25% quartile = -1.272, 75% quartile = -0.024). The modulatory parameter estimates were negative, which indicated that an enhancement of activity associated with facial affect weakened the both connections from the IOG and SPL to the OFC. Consistent with model selection, BMA estimates also found no specific tendencies for positive or negative stimuli in the connections from HPC and AMG to OFC.

Correlations between connectivity estimates and behavior

Correlation analysis between the BMA estimates of BU endogenous connections and behavioral measures across all subjects revealed a significant negative correlation between memory performance and the IOG→OFC pathway (r = -.680, p = .002). This correlation was found for faces with all emotional expressions (correlation with Pr-negative: r = -.523, p = .026; Pr-neutral: r = -.598, p = .009; Pr-positive: r = -.647, p = .004; Figure 10) and survived *Bonferroni* correction ($\alpha < .0033$, see Table 2). This negative correlation indicated that neural activity in the IOG elicited an inhibition of activity in the OFC in high performers, whereas it yields a facilitation of activity in the OFC of low performers. We found no significant correlation between bottom-up endogenous parameters and response bias. As for the modulatory parameters, the effects of negative stimuli occurred in the correlations between connection SPL→OFC with response bias for negative faces (r = .482, p = .043) and connection AMG→OFC with total response bias (r = .482, p = .043). These correlations, however, did not survive Bonferroni correction.

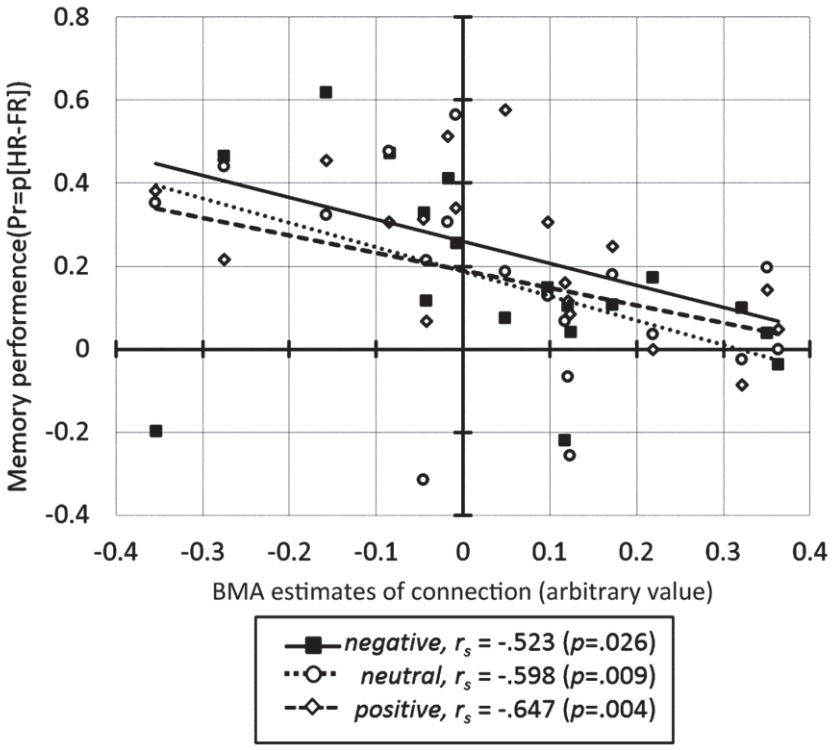

Figure 10. The correlation between the BMA parameter estimates for the IOG→OFC connection and memory performance for faces in three emotional expressions.

5.1.5 Discussion

This study aimed at examining how emotional face expression is implemented in neural networks supporting memory formation of faces. We utilized dynamic causal modeling of fMRI to study effective connectivities during face encoding and compared "bottom-up" and "top-down" models that describe the influence of emotion on memory formation. In accordance with the theory that emotion operates during memory formation via multiple regions participating in perceptual, attentional or semantic processes (LaBar and Cabeza, 2006), our DCM analysis was implemented in an extended network combining facial perception and memory formation related areas. Specifically, subsequently remembered faces were associated with higher activations compared to subsequently forgotten faces not only in limbic areas conveying the hippocampus, amygdala and posterior cingulate gyrus, but also in the superior parietal lobe, orbitofrontal cortex and cerebellum. Whereas limbic and orbitofrontal areas are frequently reported in the context of emotional memory operations, the superior parietal lobe and cerebellum are less often discussed. The superior parietal lobule is a region that can provide (spatial) attentional assistance during

perception and memory processing (Hoffman and Haxby, 2000; Ciaramelli et al., 2008; Hutchinson et al., 2009; Uncapher and Rugg, 2009; von Allmen et al., 2013). The posterior cerebellum has been also recognized in prospective cognitive and affective processing beyond strict motor planning (Schmahmann and Sherman, 1998; Cotterill, 2001; Chen et al., 2014).

The "bottom-up" model, in which emotion exerted effects along multiple parallel feed-forward pathways to the orbitofrontal cortex, prevailed across all subjects. This finding is in line with our hypothesis and suggests that emotion exerts parallel effects on multiple forward pathways to the prefrontal cortex (i.e. IOG→OFC, SPL→OFC, HPC→OFC and AMG→OFC). The OFC has been associated with elaborative processing of valence and reward (O'Doherty et al., 2001; Kringelbach, 2005), which was tested in our top-down family models. However, the winning family of bottom-up models corresponds to the view that emotional stimuli are processed simultaneously along "many roads" across the face-processing network (Kensinger and Corkin, 2004; Pessoa and Adolphs, 2010). Furthermore, the results of model selection highlighted the effective connectivities from IOG and SPL to OFC, as these connections were present in all preferred models. Previous studies showed that the inferior fronto-occipital fascicle and superior longitudinal fascicle connect the visual system with the frontal cortex along dorsal and ventral pathways (Johnson et al., 1996; Martino et al., 2010; de Sarubbo et al., 2013). The inferior connections build the ventral visual stream and engage functional coupling between visual and inferior prefrontal cortices supporting visual attention and perception (Gregoriou et al., 2009), while the superior connections extend upon the dorsal visual stream and connects to dorsal parts of the prefrontal cortex. The superior parietal lobe does not seem to have direct connections to the orbitofrontal cortex, but can provide attentional assistance for face perception during gaze perception (Hoffmann & Haxby 2000), memory encoding (Uncapher and Rugg, 2005), retrieval (Ciaramelli et al., 2008) and working memory in alignment with hippocampal activity (Ranganath and D'Esposito, 2001; Nee and Jonides, 2013; von Allmen et al., 2013) and frontal regions (Olesen et al., 2003). The modulatory effect of emotion on the IOG-OFC and SPL-OFC connectivities in our task, might suggest that emotion modulates visual processes along the dorsal and ventral visual system during memory formation. The posterior densities of the modulatory BMA parameters tended to be negative, which would indicate that activity induced by emotionally valenced stimuli in the IOG resulted in suppression of activity in the OFC. Since modulatory BMA parameters were negative for positively and negatively valenced

Table 2. Median and quartiles DCM endogenous parameters and modulatory estimates based on Bayesian model averaging (BMA) across all subjects and all models, and Spearman rho correlation (r_s) between parameters and behavioral performances

	Median	Quartiles		Memory performance (r_s)				Response bias (r_s)			
		25%	75%	total	negative	neutral	positive	total	negative	neutral	positive
Endogenous parameters											
IOG→OFC	0.073	-0.055	0.184	-.680**	-.523*	-.598**	-.647**	.026	.228	-.358	-.098
FUS→OFC	0.047	-0.065	0.268	-.067	.018	-.038	-.131	.280	-.094	.044	-.333
SPL→OFC	0.047	-0.103	0.134	.013	.090	-.079	.036	.034	-.092	.028	.401
HPC→OFC	0.247	0.038	0.317	-.201	-.026	-.174	-.199	-.255	-.265	-.011	.015
AMG→OFC	-0.085	-0.145	0.175	-.156	-.119	.038	-.311	.067	.302	-.230	.234
Modulatory estimates											
IOG→OFC, negative	-0.096	-0.499	0.583	.321	-.106	.459	.321	.267	.253	-.040	-.077
FUS→OFC, negative	-0.054	-0.342	0.109	.267	.232	.046	.451	-.098	-.373	-.218	.104
SPL→OFC, negative	0.038	-1.216	0.598	-.207	-.181	-.042	-.224	.141	.482*	.300	.094
HPC→OFC, negative	0.011	-0.277	0.534	.011	.121	-.162	-.003	-.040	-.317	-.170	-.129
AMG→OFC, negative	-0.442	-0.709	0.058	-.152	-.298	-.133	-.069	.482*	.284	.162	.280
IOG→OFC, positive	-0.095	-0.578	0.259	.034	.082	.273	-.358	-.331	.172	-.422	-.046
FUS→OFC, positive	-0.008	-0.270	0.266	.222	.038	.311	.015	-.240	-.290	-.385	-.331
SPL→OFC, positive	-0.450	-1.272	-0.024	.022	.112	.119	-.282	-.185	.187	-.187	-.437
HPC→OFC, positive	-0.027	-0.823	0.245	.154	-.059	.131	.278	.185	-.185	.071	.123
AMG→OFC, positive	-0.101	-0.564	0.166	-.232	-.063	-.249	-.166	.309	.247	.007	-.005

Note: *p < .05; **p < .0033, Bonferroni correction for multiple comparison (5 endogenous parameters and 10 modulatory parameters).

faces, it is possible that the OFC is actively suppressed by connecting regions as soon as emotional information is presented. This active suppression might prevent that emotional information does not distract from processing the facial features during the evaluation of approachability in the incidental learning task. It should be noted here, that modulation of the pathways to the OFC are independent from the intrinsic connections with the OFC.

Our second aim was to evaluate whether connectivities predict successful memory formation for emotionally valenced faces. Of all pathways to the OFC within the BU model, we found that only the IOG to OFC endogenous connection negatively correlated with memory performance. All three expressions showed a similar correlation with endogenous connectivity. This means that for subjects with higher performance neural activity in the IOG caused a suppression of neural activity in the OFC, whereas in low performers activity in the IOG caused a facilitation of activity in the OFC. This mechanism was slightly more pronounced for positive face expressions, but there was no difference in correlation coefficients for the different emotional expressions. On average, there was a weak positive connectivity from the IOG to the OFC, as illustrated in Figure 10, yet our results suggest that individual differences on the signal transfer between the IOG and OFC is associated with subsequent memory performance. One potential explanation for this effect might be that a higher decoupling between the visual processing areas and the frontal cortex is supportive during memory formation, because it may prevent the frontal cortex from being overloaded during visual processing. Several studies reported increased functional coupling in resting state functional connectivity MRI between the hippocampus and the frontal cortex during and immediately after learning (Ranganath et al., 2005, Tambini et al., 2010), and between visual areas and the frontal cortex immediately after learning (Stevens et al., 2010). Few studies effectively investigated neural coupling during episodic memory formation, except for a few intracranial EEG studies that show coupling and decoupling between brain regions relevant for memory formation (Fell et al., 2001, Sehatpour et al., 2008, Axmacher et al. 2008). These studies suggested that sustained neural decoupling follows transient coupling between visual and hippocampal regions during successful memory formation. As far as we know such mechanisms have not yet been demonstrated between occipital and frontal regions. Yet, one might speculate that decoupling can follow transfer of information during coupling of neural networks. Such a mechanism might prevent that sensory information interferes with higher order processing of information. Thus, although evidence is

still sparse, we tentatively suggest that the likelihood for memory formation to occur increases when the orbitofrontal cortex is temporary decoupled during evaluation of faces with different emotional expressions. Another point to note is that we found no differential effect of emotional valence on the association between connectivity and memory formation. It is important to remind, however, that we found no differential effect of emotional valence on memory performance either, so that inferences between emotional memory and connectivity cannot be drawn without further investigation. Taken together, model selection indicated that emotion modulated the IOG to OFC connection, while individual differences in memory performance were associated with endogenous connection strength, independently of emotional face expression. We thus suggest that the connectivity results tend to be in line with other views that emotion exerts parallel effects on as perception (Calder and Young, 2005), attention and memory (Talmi et al., 2008).

Dynamic causal modeling of fMRI provided an effective approach to investigate the effects of emotional face expression on memory formation. It should, however, be noted that combining and comparing Bayesian statistics with classical statistical approaches underlies limitations for interpretation of the data because DCM uses full time courses to estimate best fitting models, whereas correlations with connectivity estimates has much less statistical power. Nevertheless, we had a conservative classical statistical approach and sufficient statistical power to infer that connectivity estimates for the IOG→OFC were reliably related to memory performance. We also found that emotional face expression affected response bias, but not memory performance, which is in line with numerous recognition memory studies for emotional stimuli (Windmann and Kutas, 2001; Johansson et al., 2004; Dougal and Rotello, 2007; Brainerd et al., 2008). There is now some evidence that recognition memory operations might account for emotion induced differences in response bias at the behavioral and neural level. For example, emotion induced recognition bias was associated with differences in frontal ERPs during recognition memory (Johansson et al., 2004). Similar to our study the authors reported no effect emotion induced enhancement of memory performance and only reported emotion-induced enhancement of response bias at the behavioral level. Negative pictures also enhanced recollected experience, but not contextual detail of memory, and this recollected experience related to amygdala activity (Sharot et al., 2004). Enhanced focusing to specific details during recollection was also reported to induce recollected experience (Sharot et al., 2008). When negative faces induce enhanced focusing to a salient visual feature (i.e. the negative expression),

independently of whether these items were new or old, this might elicit the phenomenon of recollected experience, even when a negative face is new. So all this evidence suggests that emotion induced response bias for negative faces relates to recognition operations rather than to memory formation processes that were studied here.

It should also be noted that the sample included healthy young male adults. Some studies included females and found that menstrual cycle influenced neural responses on emotional stimuli (Protopopescu et al., 2005). We chose to measure males to induce lower variance in the behavioral and neural data and to avoid variability in the data by factors we could not control. It needs to be resolved whether our main results can be replicated in different samples, such as females, different age groups, or clinical samples for which similar networks were implicated (e.g. stress disorders, prosopagnosia) (Brewin et al., 2010;Dinkelacker et al., 2011). Moreover, our study investigated whether emotion contributed to the effective connectivity based on a network encompassing positive subsequent memory effects (remembered > forgotten). Whether emotion affects effective connectivities related to areas involved in forgetting (Daselaar et al., 2004) is another interesting topic that can be further investigated in future studies. Finally, our stimulus set included pictures of faces that had moderate valence. It is currently unclear if our main results hold under conditions of higher arousal induced by the stimuli, or by circumstantial information such as in real-world situations. Although several studies suggested that higher arousal captures attention and engages top-down elaborative processes (Dolcos et al., 2004a; Ritchey et al., 2011), it remains to be investigated whether such situations would also induce more top-down processing relative to bottom-up processing in functional connectivity. Taken together, we are confident to suggest that the pathways involved in modulating memory networks by emotion and pathways that successfully contribute to memory formation of emotional faces are partially overlapping and work in parallel in a bottom-up fashion.

Table 3. MNI coordinate of Volumes of interest for each subjects

	IOG				FUS				SPL			
	Peak coordinate			d	Peak coordinate			d	Peak coordinate			d
	x	y	z	(mm)	x	y	z	(mm)	x	y	z	(mm)
Group maximum	-40	-78	-10		-36	-52	-10		-14	-68	66	
subject 01	-36	-80	-18	9.17	-40	-56	-22	13.27	-8	-66	62	7.48
subject 02	-32	-82	-14	9.80	-38	-46	-18	10.20	-10	-66	62	6.00
subject 03	-36	-68	-14	11.49	-38	-62	-16	11.83	-12	-69.27	65.27	2.48
subject 04	-28	-80	-12	12.33	-34	-60	-16	10.20	-13.94	-67.81	65.94	0.21
subject 05	-34	-68	-16	13.11	-44	-48	-24.13	16.72	-8	-64	68	7.48
subject 06	-36	-78	-16	7.21	-36	-50	-20	10.20	-11.92	-69.62	65.46	2.69
subject 07	-38	-86	-8	8.49	-44	-44	-16	12.81	-15.85	-67.54	65.54	1.96
subject 08	-38	-84	-16	8.72	-42	-48	-20	12.33	-25.94	-67.94	59.94	13.39
subject 09	-42	-82	-6	6.00	-46.23	-55.62	-3.54	12.63	-21.44	-65.11	65.11	8.03
subject 10	-44	-78	4	14.56	-46	-60	-20	16.25	-14	-64	66	4.00
subject 11	-22	-88	-10	20.59	-36.06	-52.06	-16.06	6.06	-17.91	-71.30	61.39	6.89
subject 12	-32	-72	-12	10.20	-40	-46	-20	12.33	-8	-66	66	6.32
subject 13	-42	-78	-12	2.83	-38	-50	-22	12.33	-17.44	-71.11	61.11	6.74
subject 14	-40	-84	-12	6.32	-38	-50	-22	12.33	-12	-63.64	69.64	6.02
subject 15	-36	-74	-14	6.93	-36	-50	-20	10.20	-14	-67.64	65.64	0.51
subject 16	-42	-78	-10	2.00	-34	-64	-14	12.81	-15.93	-63.63	67.56	5.02
subject 17	-42	-80	-12	3.46	-38	-62	-18	12.96	-15.7	-65.3	67.1	3.37
subject 18	-36	-76	-12	4.90	-34.09	-42.64	-17.64	12.23	-12	-66	62	4.90

	HPC				AMG				OFC			
	Peak coordinate			d	Peak coordinate			d	Peak coordinate			d
	x	y	z	(mm)	x	y	z	(mm)	x	y	z	(mm)
Group maximum	-30	-18	-14		-26	2	-24		0	62	-18	
subject 01	-34	-18	-16	4.47	-28	4	-24	2.83	-4	62.84	-19.47	4.35
subject 02	-28	-18	-12	2.83	-28	-2	-20	6.00	-8	60	-18	8.25
subject 03	-32	-16	-14	2.83	-26	-2	-22	4.47	4	58	-22	6.93
subject 04	-32	-18	-12	2.83	-22.38	3.43	-25.14	4.06	-2.4	65	-17.5	3.87
subject 05	-32	-20	-16	3.46	-28	0	-26	3.46	6	58	-24	9.38
subject 06	-32	-18	-12	2.83	-24	4	-22	3.46	0	67.04	-14	6.44
subject 07	-32	-18	-18	4.47	-28	-2	-22	4.90	2	60	-16	3.46
subject 08	-26	-20	-12	4.90	-28	2	-20	4.47	-4	64.84	-17.47	4.94
subject 09	-32	-20	-16	3.46	-22.29	3.86	-25.64	4.47	0	60	-16	2.83
subject 10	-30	-20	-14	2.00	-22.13	1.93	-23.73	3.88	-2.1	63	-15.4	3.49
subject 11	-26	-18	-16	4.47	-28	0	-26	3.46	7.91	63.30	-17.39	8.04
subject 12	-28	-20	-14	2.83	-24	0	-26	3.46	4.11	66.78	-15.44	6.80
subject 13	-24	-24	-18	9.38	-26	2	-24	0.00	-6	60	-18	6.32
subject 14	-30	-20	-12	2.83	-24	2	-26	2.83	8	61.82	-21	8.55
subject 15	-30	-16	-14	2.00	-22	6	-24	5.66	6	62	-18	6.00
subject 16	-34	-18	-16	4.47	-24	0	-26	3.46	0	65.36	-15.6	4.13
subject 17	-34	-18	-14	4.00	-28	-2	-20	6.00	2.08	61.50	-21.33	3.96
subject 18	-22	-30	-26	18.76	-28	4	-22	3.46	-2	60	-16	3.46

Note: *d* is the distance from the individual peak coordinate to the group peak maximum.

Table 4. Model Specification and Comparison

Model specification						Model comparison based on RFX (*p*)	
Bottom-up models family	Emotional input on bottom-up pathways						
	IOG→ OFC	FUS→ OFC	SPL→ OFC	HPC→ OFC	AMG→ OFC	Expected probablity	Exceedance probablity
Model 1	✓					.002	0
Model 2		✓				.004	<.001
Model 3			✓			.003	0
Model 4				✓		.002	0
Model 5					✓	.002	0
Model 6	✓	✓				.006	.001
Model 7	✓		✓			.009	.003
Model 8	✓			✓		.003	0
Model 9	✓				✓	.004	.001
Model 10		✓	✓			.002	0
Model 11		✓		✓		.003	<.001
Model 12		✓			✓	.003	<.001
Model 13			✓	✓		.003	<.001
Model 14			✓		✓	.003	<.001
Model 15				✓	✓	.003	0
Model 16	✓	✓	✓			.104	.138
Model 17	✓	✓		✓		.005	.001
Model 18	✓	✓			✓	.005	.001
Model 19	✓		✓	✓		.013	.005
Model 20	✓			✓	✓	.004	.000
Model 21		✓	✓	✓		.003	.000
Model 22		✓	✓		✓	.006	.001
Model 23			✓	✓	✓	.003	.000
Model 24	✓	✓	✓	✓		.137	.197
Model 25	✓		✓	✓	✓	.345	.481
Model 26		✓	✓	✓	✓	.006	.000
Model 27	✓	✓	✓	✓	✓	.111	.159

Top-down models family	Inputs on OFC	Top-down modulation from the OFC				Expected probablity	Exceedance probablity
		IOG→ HPC	FUS→ HPC	SPL→ HPC	AMG→ HPC		
Model 28	✓					.004	0
Model 29	✓	✓				.009	.001
Model 30	✓		✓			.013	.001
Model 31	✓			✓		.007	<.001
Model 32	✓				✓	.007	0
Model 33	✓	✓	✓			.016	.001
Model 34	✓	✓		✓		.015	.001
Model 35	✓	✓			✓	.016	.001
Model 36	✓		✓	✓		.014	.001
Model 37	✓		✓		✓	.013	.001
Model 38	✓			✓	✓	.014	.001
Model 39	✓	✓	✓	✓		.019	.001
Model 40	✓	✓	✓		✓	.021	.002
Model 41	✓		✓	✓	✓	.020	.001
Model 42	✓	✓	✓	✓	✓	.016	.002

5.2 Study 2: "*Prolonged grief, autobiographical memory and its interaction with value orientations in China and Switzerland*"

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5.2.1 Abstract

As a psychopathological function of prolonged grief (PG) disorder, disruptions in autobiographical memory have been shown in bereaved individuals in terms of preferred access of loss-related memory and reduced specificity in non-loss-related memory. The present study examined these features in two distinct cultural groups. The cultural differences between these two groups were further investigated in the light of their personal value orientations. A sample of 30 Chinese and 30 Swiss bereaved parents who had lost their child completed the Autobiographical Memory Test (AMT) and self-reported scales to assess the severity of PG and traditional-versus-modern value orientations. Consistent with previous studies, more severe PG was found to be associated with a greater proportion of loss-related memories and reduced specificity of non-loss memories in the combined sample, particularly in response to negative cues. These manifestations were observed in the Chinese sample as a whole (but more salient in participants with low traditional values), as well as in the Swiss participants with low traditional values. By contrast, Swiss bereaved parents with high traditional values showed deliberate grief avoidance, as more severe PG was associated with a smaller proportion of loss-related memory for negative cues but a greater proportion of specific non-loss-related memory. These findings indicate that although the same psychopathological memory retrieval process apply to bereaved parents from different cultural backgrounds, and the manifestations of disruptions in autobiographical remembering are moderated by culture and personal value orientations.

Key words: prolonged grief, autobiographical memory, culture, value orientations, bereaved parents

5.2.2 Introduction

After an initial period of mourning of the death of a loved one, some bereaved individuals may remain static, or even deteriorate, in their grief reactions such that they meet the criteria for prolonged grief disorder (PGD) (at least six months after the death) (Prigerson et al., 2009). An elevated risk of PGD has been observed in bereaved parents (Meert et al., 2011). In the 11th

version of the International Classification of Diseases (ICD-11) by the World Health Organization, PGD is proposed as a separate disorder next to posttraumatic stress disorder (PTSD) (Maercker et al., 2013), with differences in their core symptoms and memory-related symptoms (Maercker & Znoj, 2010). Specifically, individuals who suffer from PGD display persistent and pervasive yearning or longing for the deceased, as well as memory-related clinical symptoms such as a preoccupation with images and thoughts of the deceased, and rumination of bittersweet memory about the deceased and other related experiences (Maercker et al., 2013). Therefore, central to numerous models of the maintenance and development of prolonged grief (PG) is the pathological pathway of integrating memories related to the bereavement (Boelen et al., 2006; Maccallum & Bryant, 2013). As both ICD-11 and DSM-5 have proposed cultural considerations of psychopathology (Kirmayer & Ryder, 2016; Maercker et al., 2013), the goal of the present study was to investigate the grief-related psychopathological function in the autobiographical memory system in a cross-cultural context, particularly in the samples of Swiss and Chinese parents whose child died.

Disruptions in autobiographical memory following bereavement

Autobiographical memory system comprises memories of personal events from an individual's life. It has been previously shown that the bereavement experience may cause disruptions or alterations in the autobiographical memory system (Boelen et al., 2010a; Maccallum & Bryant, 2010). Several characteristic manifestations associated with prolonged grief have been revealed in previous studies. First, during an autobiographical remembering when individuals are asked to retrieve events that happened at a particular time and place (i.e. specific memory), individuals suffering from PG preferred access to memories related to the deceased by retrieving more loss-related memories, than the group individuals without PG (Maccallum & Bryant, 2008, 2010). Second, bereaved individuals exhibited a reduced specificity when recalling events that were unrelated to the deceased; but they maintained normal specificity when recalling events related to the deceased (Golden et al., 2007; Robinaugh et al., 2013). The reduced specificity in non-loss-related memory was associated with a higher severity of PG (Boelen et al., 2010a; Eisma et al., 2015). The reduced specificity during autobiographical remembering, also called overgeneral retrieval process, has been interpreted through the mechanisms of “ruminative thinking” and “functional avoidance of negative affect” (Williams, 2006). The ruminative thinking that originates from ones repeated rumination of self, symptoms,

and their implications can strengthen retrieval of general memories. The functional avoidance serves as a strategy to narrate events selectively in order to generate less emotional distress. In addition, a bias was shown in autobiographical remembering, where preferential accessibility to loss-related memory and relatively reduced specificity in non-loss-related memory were shown to be particularly sensitive to negative emotion cues (Golden et al., 2007; Maccallum & Bryant, 2010). This finding provides supports for the overgeneral process of the functional avoidance of negative affect, suggesting that bereaved persons tend to avoid loss-related memories and retrieve non-specific memories when narrating memories related to negative emotions. Nevertheless, traumatic memories such as bereavement have been found to be immune from the overgeneral retrieval process (Boelen et al., 2010a). Traumatic memories are usually accompanied by intensive emotion and are central to the person's life story and identity of self. They are difficult to be integrated by previous autobiographical memory knowledge and are repeatedly reconsolidated by frequently voluntary or involuntary recalling (Rubin et al., 2008). Therefore, grief-related preoccupation with the images and thoughts of the deceased can result in preferential retrieval of loss-related memories and remain specificity in loss-related memories. Overall, the disruptions in the autobiographical memory system may be consequences of two competitive processes between "preoccupation of traumatic memories" and "functional avoidance of negative affect".

To date, the majority of the literature focuses on bereaved individuals from Western cultures. Culture cannot only diversify expression of grief (Rosenblatt, 2008), grieving process (Bonanno et al., 2005), and coping process to stress and trauma (Chun et al., 2006), but also affect every-day autobiographical memory (Ross & Wang, 2010) and the remembering of trauma (Jobson et al., 2014). This raises the question: do the characteristic manifestations of the disruptions in autobiographical memory following bereavement manifest in a non-Western context? Furthermore, a fundamental question is whether culture or cultural components affect the competitive mechanism between the two memory processes underlying disruptions in autobiographical memory.

Cultural similarities and differences in disruptions of autobiographical remembering

Autobiographical memories aid the development and maintenance of self-conception (Wang & Conway, 2004). The conceptual self is socially and culturally constructed and is comprised of personal script, self-with-other units, relational schema, possible selves, attitudes,

values, and beliefs (Conway, 2005). One important cultural distinction that influences the conceptual self at the macro level is an independent vs. an interdependent orientation of self-construal. The current study conducted a cross-cultural comparison between China, a culture that has a long historical tradition and typically collectivist contexts (Triandis et al., 1990), and Switzerland, a culture that has elevated individualist values and egalitarian social norms (Would Value Survey Group, 1994). Differences between Western and non-Western cultures, such as the Swiss and Chinese cultures, are commonly characterized by distinct construal of the self (Markus & Kitayama, 1991; Markus & Kitayama, 2010). In individualistic cultures (typically "Western") that perceive the self as an independent, autonomous, internally coherent entity, memories of personal experiences help individuals to distinguish themselves from others and contribute to an independent self-construal. Whereas in collectivistic cultures (typically "Eastern") that perceive the self as an interdependent and relatedness entity, autobiographical memories are less relevant to self-definition but more interconnected with other people and places within a network of relationships. The cultural concept of the self can affect the accessibility of autobiographical memories such that cultural differences are evident in the content and specificity of personal memories (for a review, see Ross and Wang, 2010)).

According to the "threat to conceptual self model" (Jobson, 2009), traumatic memories can override the cultural distinctions in interdependent vs. independent orientation in self-construal. It suggests that a traumatic event that challenges personal survival can activate an autonomous goal to protect personal safety and to personally control and master the situation, regardless of the original dominant self-orientation. This model has been supported by empirical studies that showed that the differences in self-construal between independent vs. interdependent orientations (i.e. between cultures) were reflected in everyday memories but not in traumatic memories (Jobson & O'Kearney, 2006; 2008). Following traumatic events, despite different cultural backgrounds, individuals with PTSD manifested pan-cultural disruptions in the autobiographical remembering such as cultural similarities in the phenomenological properties (i.e., recollection, language, fragmentation, and rehearsal) of the trauma memories (Jobson et al., 2014), and an overgeneral retrieval style (Jobson & Cheraghi, 2015). Specifically, Jobson et al. (2014) found that Australian, British, and Iranian trauma survivors with PTSD recalled a significantly smaller proportion of specific memory, and a greater proportion of trauma-themed personal memory, than trauma survivors without PTSD. These studies suggest that although culture affects both

what people remember and how they use their memory in general (Ross & Wang, 2010), the psychopathological function of the preoccupation of trauma memory (e.g. loss-related memories) may apply to people from different cultural backgrounds. It would therefore be a reasonable assumption that the preoccupation-related manifestations of disruptions in autobiographical memory (i.e. individuals with severe prolonged grief show a preferential access to loss-related memories that are 'immune' from overgeneral process) would be observed in both Chinese and Swiss bereaved individuals (Hypothesis 1).

Nevertheless, culture has an impact on the coping strategy of functional avoidance of negative affect. Autobiographical memory has a social function, and telling an autobiographical memory can entail interpersonal or social interactions (Bluck, 2003). Autobiographical remembering among bereaved persons would therefore be associated with the individual's severity of prolonged grief, and would also be affected by their strategies of coping with grief, particularly their tendency towards thinking and talking about the deceased and bereavement events (i.e. deliberate grief avoidance vs. disclosure intention) (Baddeley & Singer, 2009; Eisma et al., 2013). Previous cross-cultural studies have showed cultural differences between Chinese and Western cultures in the grief expression and grieving processes of bereaved parents (Bonanno et al., 2005; Lalande & Bonanno, 2006; Xiu et al., 2016). A study by Xiu et al. (2016) suggested that Swiss bereaved parents shared a similar grief symptom profile with the Chinese sample, but manifested more severe grief-related preoccupation than the Chinese bereaved parents. These cultural differences were attributed to the independent self of Swiss bereaved parents who prioritized the private internal aspects of self and self-reliance. The authors speculated that Swiss parents with an independent self-construal might focus on personal perceptions and their connection with the child, which may result in a preoccupation with vivid and emotional images and thoughts of the deceased (i.e. specific loss-related memories). In contrast, the interdependent self in the collectivistic Chinese culture emphasizes the public aspects of self and relies on social support. The death of a child was originally stigmatized as an unlucky or cursed event in traditional Chinese culture and having no child is extremely non-filial to family in Confucianism (Zheng & Lawson, 2014). This may cause a conflicting situation for Chinese parents who may wish to seek social support but feel the pressure of a taboo about discussing their bereavement experiences. This was supported by Bonanno et al. (2005) who found that Chinese parents exhibited a more intensive deliberate grief avoidance of thinking and

talking about the deceased than the American bereaved parents. During autobiographical remembering, deliberate grief avoidance may occur in accordance with the "functional avoidance hypothesis" of reduced memory specificity (Williams, 2006). This suggests that in the overgeneral retrieval process, individuals with deliberate grief avoidance may inhibit the retrieval of specific loss-related memories, as these memories are accompanied by negative emotions. Hence, it is justifiable to expect preferential narratives of specific loss-related memories for Swiss parents with severe prolonged grief.

Bonanno et al. (2005) further revealed a cultural distinction in the relationship between deliberate grief avoidance and grief severity. Although bereaved Chinese parents had a salient tendency towards grief avoidance in general, the deliberate grief avoidance that exacerbated grief severity among American participants did not appear to be maladaptive for the Chinese. One plausible speculation is that the greater social support from interpersonal connectedness and traditional mourning practices in a collectivism culture could facilitate the grief processing regardless of deliberate grief avoidance (Braun & Nichols, 1997). The reluctance to talk about traumatic experiences in China may be seen as a result of one's own cultural values that life incorporates happiness and suffering and traditional culture encourages people to pursue rational happiness (Zheng & Gray, 2015). In contrast, reluctance to talk about the traumatic experience would more often be viewed as a deficiency in a Western individualistic culture that advocates maximizing the pleasure and minimizing the pain of individuals (Müller et al., 2009; Zheng & Gray, 2015). This suggests that the influence of grief avoidance of loss-related memories on symptom severity depends on the culture, and may particularly be a risk factor for bereaved persons from Western individualistic culture. As Lardi et al. (2010) found that Swiss adults demonstrated similar characteristics of autobiographical memories to those observed in American participants, we therefore speculated that memory manifestations due to grief avoidance may be associated with the level of symptom severity in the bereaved Swiss parents, but not in the bereaved Chinese parents. Hence, we would expect that cultural differences in disruptions of autobiographical remembering would emerge in the retrieval of specific loss-related memory and the overgeneral memory process of the functional avoidance of negative affect (i.e. prolonged grief severity is associated with reduced specificity in non-loss memories in the context of negative emotion) (*Hypothesis 2*).

The moderation role of personal value orientations

Societal culture is external to the individual, yet it is underpinned by a complexity of meanings, values, and beliefs of the individuals in that society (Schwartz, 2014). Recently in the field of health and clinical psychology, there is an interest to portray the underlying mechanisms about how cultural components maintain the cultural similarity and/or facilitate potential cultural differences across distinct social and cultural contexts. The main emphasis has been placed on the role of basic value orientation (Burri & Maercker, 2014; Maercker, 2001; Maercker et al., 2015; Wang et al., 2014; Zimmermann et al., 2014), as values have been regarded as crucial components of culture and play a central role in the meaning system of culture (Schwartz, 2014). Schwartz (1992) views value orientations as the criteria that individuals use to select and justify actions and to evaluate people and events. Values thus have a cognitive function to evaluate the importance of events and a motivation function to guide one's behavior. Specifically, values can influence mental health via coping processes such as the perception of consequence (Vecchione et al., 2012), the selection of coping strategies (Tweed & Conway III, 2006) and social sharing processes (Maercker et al., 2009).

In mental health research, Maercker et al. (2009) simplified the "Theory of basic human values" (Schwartz, 1992) for reasons of its application in clinical psychology. The theory is based on Inglehart's (1997) perspective on the evolvement of traditional and modern values in the social modernization. Traditional values (i.e. conformity, tradition, benevolence, security, and universalism) emphasize collectivism, submissive self-restriction, preservation of traditional practice, protection, and stability; whereas modern values (i.e. self-direction, stimulation, hedonism, achievement, power) present the motivation to pursue personal success and dominance over others or personal gratification. According to the definitions, traditional values are relevant to the interdependent self, as both emphasize relationships with others or groups in specific social and cultural contexts. Whereas modern values are relevant to the independent self, as both focus on personal values and self-actualization. In support of these perspectives, research has shown traditional values to be related to different stress-associated syndromes by mediating social sharing processes and interpersonal factors, such as the intention to tell others about their experiences and perceived support from their social network (Maercker et al., 2009; Müller et al., 2011). Modern values are also strongly associated with personal constructs (e.g. resilience, a personal motivational force that drives individuals toward self-actualization), rather than interpersonal factors (Maercker et al., 2015).

Furthermore, the motivational function of value orientations can foster emotion and connect with the working-self in the memory system of self (Conway & Pleydell-Pearce, 2000). This system posits that a motivational hierarchy of goals encodes and integrates memories into the autobiographical memory knowledge base. In line with this perspective, Ross and Wang (2010) summarized relationships between cultural self-views and remembering to indicate that culture can influence remembering through different values and beliefs, particularly values pertaining to self. Researches by Robinson and Clore (2002) and Oishi et al. (2007) found that beliefs and values could influence retrospective reports of emotional experiences. Therefore, given that both personal value orientations and autobiographical memories are hierarchically organized by self-construal, the current study will examine whether value orientations can influence bereaved individuals' autobiographical remembering. Specifically, previous studies found that for both Chinese crime victims and Swiss older adults who had experienced significant life stress, their traditional values were positively related to intention to tell others about the traumatic events, whereas modern values showed no correlation (Maercker et al., 2009; Müller et al., 2011). This indicates that traditional values may be associated with the process of "functional avoidance of negative affect". We therefore assume a cultural similarity that traditional values have a moderation effect in the association between prolonged grief severity and retrieval of loss-related memories and specificity of non-loss memory; however, we would not expect this to appear for modern values (Hypothesis 3). Previous research showed that a high level of traditional values was related to poor self-perceived social support, with a negative association with social acknowledgement as a victim and a positive association with inner pressure to disclose traumatic experiences (Maercker et al., 2009). It is therefore expected that high level of traditional values will be associated with intensive grief avoidance.

In conclusion, previous literature on bereavement has shown associations between prolonged grief severity and autobiographical memories in terms of grief-related content and specificity. Two competitive processes of "preoccupation of traumatic memory" and "functional avoidance of negative affect" build a fundament to these relationships. The aim of the current study is to consider these memory manifestations in cross-cultural backgrounds. Furthermore, this study aims to explore the cultural similarities and differences in relation to the moderation effects of cultural context and a large-scale cultural component (traditional vs. modern values).

This may illustrate the underlying mechanisms how cultural components facilitate potential cultural differences across different contexts.

5.2.3 Methods

Participants

Data in the current study was collected as part of a larger cross-cultural project "prolonged grief and autobiographical memory in bereaved parents" in the Chinese metropolis of Beijing and Chengdu and the German-speaking region of Switzerland. The study recruited middle-aged parents (up to 65 years old) whose child died from 6 months to 10 years ago. Participants' children were at least 6 months old when he/she died. To access surficial autobiographical material on interactions before the death of child the study did not include prenatal or postnatal (up to 6 months) child losses. For more details about recruitment procedure and inclusion/exclusion criteria for participants, please refer to Xiu et al. (2016). Individuals who chose to participate were invited to take part in an interview, which involved collections of basic personal data (demographical information and loss-related information), an Autobiographical Memory Task, and questionnaires. This cross-cultural study was conducted in accordance with the guidelines of the ethics review board of the University of Zurich. All participants provided written informed consent in advance.

The present study includes participants who finished the Autobiographical Memory Task and provided full data in basic personal information and questionnaires. The whole sample comprised of 30 bereaved Chinese parents (9 male, age = 55.25 ± 6.59 years old, education in year= 10.47 ± 2.23) whose children died between 1 to 10 years ago (24 male children, age at death = 25.02 ± 6.28 years old, bereavement period = 3.71 ± 2.58 years). Cause of death for the Chinese children are one natural accident, 5 human-made accidents and 24 illness-related death. The Swiss sample comprised of 30 German-speaking bereaved parents (7 male, age = 44.94 ± 8.07 years old, education in year = 15.92 ± 4.45) whose children died between 0.5 to 6 years ago (18 male children, age at dead = 10.13 ± 7.7 years old, bereavement period = 2.77±1.71). The cause of death for Swiss children are 5 natural accidents, 5 human-made accidents, 16 illness-related death, and 4 suicides. The Chinese sample included 2 couples of dyads parents (i.e. mother and father both from the same bereavement), and the Swiss sample included 4 couples.

Group differences were tested in background variables such as parents' gender (x^2= .09, p= .77), the age of the parent (F[1,58]= 29.34, p < .001), the age of deceased child (F[1,58]=

67.42, $p < .001$), parents' education in year (F[1,58]= 33.52, $p < .001$), the deceased child's gender (x^2= 1.98, p= .16), and bereavement period (F[1,58]= 2.79, p = .10).

Measures

Autobiographical Memory Task (AMT). This task was adapted from Williams and Broadbent (1986). To prepare a cross-cultural study, new cue words were obtained through the following procedure: (1) 36 emotional cue words were first collected from previous literature on AMT; (2) Back-translation by German-English and Chinese-English bilingual researchers was adopted to translate cue words into German and Chinese. 16 words were deleted due to lack of clarity or confusion of understanding between the two cultures; (3) a group of 12 German-speaking and 12 Chinese-speaking psychological master or doctoral students rated these German or Chinese words on 5-point scales in terms of emotional valence, arousal, concreteness, and imaginary. Five positive words (happy, safe, honest, brave and relaxed) and five negative words (sad, guilt, hopeless, lonely and fear) were finally selected without significant national group difference in all four indexes.

During AMT, participants were presented with positive or negative words in the counterbalancing of ABBA sequence (e.g. safe, sad, guilt, honest etc.) and were asked to recall a specific event that happened at a particular time on a particular day for each cue. Examples of adequate and inadequate responses were given and participants completed two practice trials (e.g. book, patient) to ensure they understood the task. Cue words that participants could not response within 60s were passed. Each recounted event was then coded in terms of grief-related content and specificity. Each memory was coded as being either grief-related ("loss") or unrelated ("non-loss") content (Maccallum & Bryant, 2010). The "loss" category, included memories of events that were associated with child's death (the moments when lost the child and narratives referring to the actual death) or memories relating to an aspect of the grief experience related to child (e.g. yearning, emotion reactions, intrusion of traumatic memory, etc.). All remaining memories were coded as "non-loss" category. With regard to memory specificity, a specific event was coded meeting two criteria: a unique occurrence (a single event occurred in a particular day) and brief duration of less than one day (Singer & Blagov, 2000). Independents raters (two German-speaking raters for the Swiss data and two Chinese-speaking raters for the Chinese data) who were blind to the hypotheses completed the memory coding according to the same coding manual in English. The raters were bachelor or master level students in psychology who had

completed group training provided by first author in advance. The coding of the first 15 participants was selected to calculate the inter-rater reliability. Cohen's Kappa for memory content and specificity were .77/.77 for the Chinese sample and .77/.83 for the Swiss sample. The memories that had inconsistent coding in the initial independent coding procedure were discussed and recoded with mutual agreement.

ICD-11 Prolonged Grief Disorder Scale (PGDS). This scale is an extended version of the Inventory of Complicated Grief-Revised (ICG) (Prigerson & Jacobs, 2001) and comprises 20 previously used items and three new items based on the newly conceptualized diagnosis of prolonged grief disorder in ICD-11 by WHO (Maercker et al., 2013). The participants were requested to describe how often they had felt grief over the past month due to losing their child, using a 5-point scale: 1 = *Almost never* (less than once a month), 2 = *Rarely* (monthly), 3 = *Sometimes* (weekly), 4 = *Often* (daily) and 5 = *Always* (several times a day). In this study, we utilized the sum scores to manifest the intensity of prolonged grief. The internal consistency (Cronbach's α) was .93 for the Chinese sample and .92 for the Swiss sample.

Portrait Values Questionnaire (PVQ) (Schwartz et al., 2001). This self-report scale comprises 21 items that are grouped into 10 subscales based on the circumflex models of basic values. Each item describes a person in two sentences ('portrait'). Participants were asked to evaluate how similar they are to the portrayed person via a 6-point scale, ranking from 1 "*very similar*" to 6 "*very dissimilar*". The German and Chinese versions of the PVQ have been validated previously for language (European Social Survey, 2008). Preliminary analysis firstly reverses the coding of all the value items (old code 1 = new code 6, old code 2 = new code 5, etc.). In present study, the PVQ subscales of conformity, tradition, and benevolence, summed up to produce the traditional value sum score (6 items). The subscales of self-direction, hedonism and stimulation summed up to generate modern value sum score (6 items). The internal consistency (Cronbach's α) of traditional values and modern values was .81/.81 for the Chinese sample and .64/.83 for the Swiss sample.

5.2.4 Results

Grief-related content and memory specificity

In the preliminary analysis using R 3.0.2, the proportion of memory for each participants was obtained in terms of grief-related content (loss vs. non-loss), and specificity for each content category (specific loss-related vs. specific non-loss-related memory). For example, proportion of

specific loss-related memory was obtained by dividing the number of memories that were coded as both specific memory and grief-related content by the total number of narrated memories. As shown in Table 5, all memory indexes were calculated for all cues, as well as separately for negative and positive priming cues.

Table 5. Mean proportions of grief-related content memory and specific memory in response to positive or negative cues in each country, and their group differences

	Chinese (mean [SD])			Swiss (mean [SD])			Group difference (*F*)		
	All cues	Pos.	Neg.	All cues	Pos.	Neg.	All cues	Pos.	Neg.
Grief-related content of memory									
Loss-related	.31 (.16)	.13 (.19)	.48 (.25)	.16 (.16)	.46 (.25)	.46 (.25)	.39	2.08	.02
Memory specificity for each content category									
Specific loss	.08 (.12)	.05 (.14)	.11 (.14)	.13 (.09)	.06 (.10)	.19 (.15)	3.16$^{\#}$	.02	7.55**
Specific non-loss	.22 (.16)	.32 (.23)	.13 (.19)	.30 (.19)	.39 (.15)	.21 (.26)	.75	.29	.40
Overall specific	.30 (.21)	.37 (.27)	.24 (.21)	.43 (.20)	.45 (.27)	.40 (.28)	2.76	.31	4.51*

Note: Group difference was tested by General linear model with controlling for age of parent, the age of child, and parents' education in year. $^{\#}$ p<.08, *p < .05, ** p < .01. Pos. = positive cues; Neg. = negative cues.

To examine whether there were cultural differences in memory retrieval in terms of specificity and loss-related content, repeated ANOVA analyses were preformed to test main and interaction effects between culture (China vs. Switzerland) and priming cues (positive vs. negative cues). Regarding overall memory specificity, main effects were found in both culture (F [1, 58] = 5.24, p = .03, partial η^2 = .08) and priming cues (F [1, 58] = 5.25, p = .03, partial η^2 = .08). However, there was no interaction effect (F [1, 58] = .96, p = .33, partial η^2 = .02). Specifically, Swiss participants reported significantly larger proportion of overall specific memory ($T_{\text{Swiss vs. Chinese}}$ = 2.29, p =.02, d = .63), particularly in response to negative cues ($T_{\text{Swiss vs. Chinese}}$ = 2.53, p = .01, d = .65). Regarding the ratio of grief-related memory content, culture had neither main effect (F [1, 58] = .01, p = .94) nor interaction with priming effect (F [1, 58] = .30, p = .59, partial η^2 = .005). Main effect appeared in the priming cues (F [1, 58] = 84.02, p<.001, partial η^2 = .59) with bereaved parents recalling a larger proportion of loss-related

memory in response to negative cues than in response to positive cues (Positive vs. negative: $T_{Chinese} = -6.22$, $d_{Chinese} = -1.58$, $T_{Swiss} = -6.89$, $d_{Swiss} = -1.43$, both $p<.001$).

As this study concerned memory specificity that differentiated according to loss-related or non-related content, we performed repeated ANOVA analyses to examine the main and interaction effects between specificity category (specific loss-related vs. specific non-loss-related memory), culture (Swiss vs. Chinese) and priming cues (positive vs. negative cues). Main effects were found in the culture (F [1, 58] = 5.24, p = .03, partial η^2 = .08), priming cues (F [1, 58] = 5.25, p = .03, partial η^2 = .08) and specificity category (F [1, 58] = 34.62, $p<.001$, partial η^2 = .37). Although both priming cues and specificity category showed no interaction with culture, they interacted with each other (F [1, 58] = 29.80, $p<.001$, partial η^2 = .34). Notably, compared with Chinese sample, Swiss participants reported larger proportion of specific loss-related memory in response to negative cues (T = 2.16, p = .03, d = .55, without covariant), supporting the first part of *Hypothesis 2.*

Furthermore, as previous studies has summarized a series of intrapersonal and situational factors that could influence the grieving process and bereavement outcomes (Stroebe *et al.*, 2006; Xiu *et al.*, 2016), we performed *Spearman* correlation analyses to examine whether demographical variables (parents' age, gender and education in years) and loss-related variables (deceased child's age and gender, cause of death, bereaved period) were associated with autobiographical remembering in bereaved individuals. For the Chinese sample, the retrievals of specific memory in response to positive cues were positively correlated with parent's age ($r_{spearman}$ = .45, p = .01), parent's education in year ($r_{spearman}$ = .46, p = .01), and deceased child's age ($r_{spearman}$ = .34, p = .06). For the Swiss sample, a significant result was only found for the parent's gender, with a higher proportion of specific loss-related memory in response to positive cues for Swiss male (F = 10.12, p = .004). As significant group differences were also observed in parent's age and education in year, and deceased child's age, it was our intention to control these three variables when comparing cultural differences in autobiographical remembering. With regard to group differences in the proportion of each memory category, the General linear model analyses tested the effect of culture (China vs. Switzerland) with controlling for the group differences in background variables. Consistent with ANOVA analyses, significant findings were shown in overall specific memory and specific loss-related memory, particular in response to negative cues (see Table 5).

Association of memory characteristics with PG severity

Table 6. Partial correlations between characteristics of autobiographical remembering with the severity of prolonged grief in each country according to priming cues (r-Spearman)

Memory category	Whole group		Chinese		Swiss	
	Pos.	***Neg.***	***Pos.***	***Neg.***	***Pos.***	***Neg.***
Loss-related memory	.13	.25#	.26	.36#	-.14	-.02
Specific loss-related	.06	.10	.19	.27	-.01	-.30
Specific non-loss-related	.07	-.26*	-.18	-.39*	.41*	-.07
Overall specific	.10	-.18	-.09	-.14	.43*	-.22

Note: Partial Spearman correlation was adopted with controlling for parent's age and education in year, and deceased child's age. # $p<.08$, *$p < .05$

The sum score of *Prolonged grief disorder scale* represented the severity of prolonged grief without significant group difference; $M_{Chinese} = 63.07$, $SD_{Chinese} = 22.17$, $M_{Swiss} = 54.27$, $SD_{Swiss} = 13.95$, $T_{Chinese\ vs.\ Swiss} = 1.84$, $p = .07$, $d = .48$.

Hypotheses on the associations between PG severity and memory disruptions (*Hypothesis 1* and *2*) were tested for each emotional cues by partial correlation with *Spearman*'s Rho with controlling the age of parents and deceased child and parents' education in year (see Table 6). As expected for the whole sample, bereaved parents with more severe PG tended to recall more loss-related memory ($p = .06$). However, in response to negative cues they showed reduced specificity in the non-loss-related memory ($p = .04$) and a non-significant increase in specificity in the loss-related memory. When considering the associations in different national samples, Chinese and Swiss bereaved parents exhibited different patterns. Nevertheless, hypothesis 1 was confirmed for the Chinese sample, as more severe PG severity was marginally significantly correlated with a larger proportion of loss-related memory ($p = .06$) and non-significantly correlated with the proportion of specific loss-related memory. In contrast, both of the proportions of loss-related memory and specific loss-related memory were non-significantly correlated with PG severity in the Swiss sample. Instead, Swiss participants with more severe PG recalled a larger proportion of specific non-loss-related memory ($p = .02$) in response to positive cues, which might result from deliberate grief avoidance of Swiss bereaved individuals.

Hypothesis 2 proposed that there would be cultural differences in the memory process of functional avoidance of negative affect. It is supported by the results that the proportion of specific loss-related memory had a moderately positive correlation with PG severity in the Chinese sample, but a negative correlation in the Swiss sample. Hypothesis 2 was further confirmed by the finding that the proportion of specific non-loss-related memory had a significant negative correlation with PG severity in the Chinese sample (p = .03) in response to negative cues, whereas there was no correlation in the Swiss sample.

Cultural difference in correlation coefficients between two national samples were further conducted via significant test of *Fisher* r-to-z transformation. Significant group differences were found in associations of PG severity with overall specific memory for positive cues ($Z_{\text{Chinese vs. Swiss}}$ = -2.02, p = .04), specific loss-related memory for negative cues ($Z_{\text{Chinese vs. Swiss}}$ = 2.15, p = .03), and specific non-loss-related memory for positive cues ($Z_{\text{Chinese vs. Swiss}}$ = -2.27, p = .02).

Combing prolonged grief, value orientations, and culture to predict memory content and specificity

The study first validated the construct of modern values (i.e. self-direction, hedonism, and stimulation) and traditional values (i.e. conformity, tradition, and benevolence) in our sample data. The configural invariances of traditional and modern values were examined using a single-group Confirmatory Factor Analysis (CFA) for each country sample via AMOS 20. "Maximum likelihood estimation" was used with its default settings for standard errors and test statistics. Model fit was evaluated using the conventional χ^2 test. CFA confirmed the modern-traditional values construct in both the Chinese and Swiss samples, Chinese: χ^2 = 6.70, df = 8, p= .84, GFI= .93; Swiss: χ^2 = 3.40, df = 8, p= .91, GFI= .96. Both Chinese and Swiss bereaved samples showed a larger traditional values (TV) sum score than modern values (MV) (Chinese: M_{TV} = 26.87, SD_{TV} = 5.26, M_{MV} = 19.43, SD_{MV} = 5.89, t = 6.23, p < .001, d = 1.33; Swiss: M_{TV} = 25.33, SD_{TV} = 4.41, M_{MV} = 22.67, SD_{MV} = 5.97, t = 1.80, p = .08, d = .51).

Second, to investigate the moderation effect of personal value orientations in different cultural contexts (*hypothesis 3*), general linear model analyses were used to test the interactions among prolonged grief severity, value orientations, and culture in the whole sample. The effects of modern values and traditional values were separately tested in different models to predict the memory indexes (i.e. proportion of loss-related memory, specific loss-related memory, and specific non-loss-related memory). After controlling for background variables (i.e. the age of

parent and deceased child, and parents' education in years), each model examined the main effects of prolonged grief, one value orientation, and culture. Also three two-way interactions (culture × prolonged grief, culture × value orientation, prolonged grief × value orientation) and one three-way interaction (prolonged grief × value orientation × culture) were examined. As shown in Table 7, significant results were shown in the interactions between prolonged grief severity and traditional values for the retrieval of loss-related memory (F [1, 49] = 16.33, p < .001, partial η^2 = .25) and specific non-loss memory (F [1, 49] = 8.04, p < .01, partial η^2 = .14). No significant result were shown in the interactions between prolonged grief and modern values. This supports *Hypothesis 3* that traditional values, not modern values, have a moderation effect in the associations between prolonged grief severity and disruptions in autobiographical memory. Furthermore, a significant three-way interaction was shown in the loss-related memory (F [1, 49] = 5.32, p = .03, partial η^2 = .10), indicating that the moderation effect of traditional values on the association between prolonged grief and memory indices differed between the Swiss and Chinese samples.

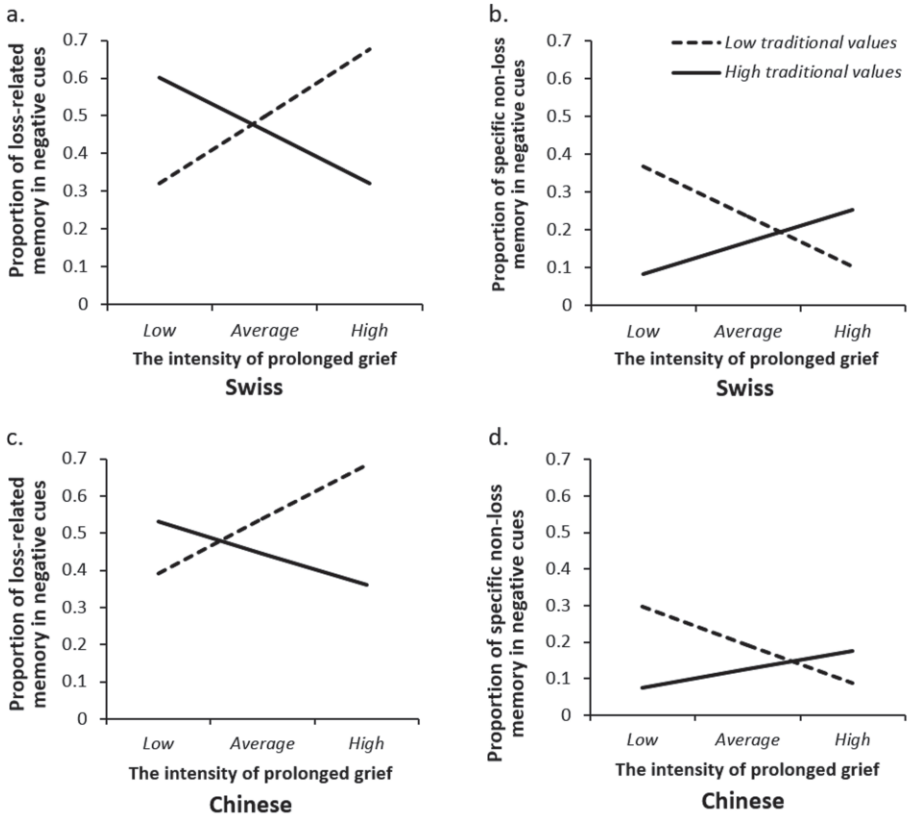

Figure 11. The moderation effects of personal value orientations on the associations between prolonged grief severity and autobiographical memory.

Table 7. Testing the moderation effects of culture (Switzerland vs. China) and personal value orientations (i.e. traditional and modern values) in the relationship between prolonged grief severity and memory indices with controlling for parent's age

	Loss-related memory		Specific loss memory		Specific non-loss memory	
	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
Moderation effects of culture and traditional values						
Prolonged grief	-.20	-.10	<.001	-.38	.46	-.03
Traditional values	-.18	-.31	.06	.25	.02	-.001
Culture	-.71	-.09	-.05	-1.25**	-.22	-.32
Culture × Grief	.27	.41	.10	.60*	-.05	-.23
Culture × Traditional values	.26	.10	.09	-.38	-.22	-.19
Grief × Traditional values	-.33	-.95***	.005	.02	.05	.68*
Grief × Traditional values × Culture	.36	.69*	.01	-.17	-.08	-.49
Moderation effects of Culture and modern values						
Prolonged grief	-.03	.06	.04	-.46	.45	-.20
Modern values	.33	.18	-.29	-.17	-.04	-.06
Culture	-.75	-.15	.01	-1.35**	-.20	-.38
Culture × Grief	.13	.19	.21	.64*	-.61#	-.09
Culture × Modern values	-.50	-.23	-.05	.01	-.01	-.04
Grief × Modern values	.004	.11	-.08	.10	-.09	.06
Grief × Modern values × Culture	.03	-.17	.24	-.11	-.04	.01

Note: # p<.08, *p < .05, **p < .001. Pos. = positive cues; Neg. = negative cues.

To better understand these moderation effects, the interactions were illustrated following the procedure by Aiken *et al.* (1991). We divided each sample into a high-level group and a low-level group according to the median value of traditional values, and calculated the partial Spearman correlation within each subgroup after controlling for background differences. Figure 12.a and 12.b illustrate the associations between prolonged grief severity and memory indices

within the high-traditional values (high-TV, larger than the median of traditional values) and low-traditional values (low-TV) groups for the Swiss sample. Their PG severity showed significant correlations with the proportion of loss-related memory, which differed between the low-TV and high-TV groups (high-TV Swiss group: $r_{Spearman}$ = -.80, n = 15; low-TV Swiss group: $r_{Spearman}$ = .86, n = 15; both p<.001). A negative correlation between PG and the proportion of specific non-loss-related memory was also shown in the low-TV Swiss group for negative cues (high-TV Swiss group: $r_{Spearman}$ = .40, p = .16, n = 15; low-TV Swiss group: $r_{Spearman}$ = -.61, p = .01, n = 15). In addition, Figure 12.c and 12.d illustrate the associations the associations. Using partial *Spearman* correlation analysis with controlling for the background variables, prolonged grief severity showed a marginally significant positive correlation with the proportion of loss-related memory only for the low-TV group (high-TV Chinese group: $r_{Spearman}$ = .11, n = 15, p = .74; low-TV Chinese group: $r_{Spearman}$ = .56, n = 15; p = .06). Prolonged grief severity also showed a significant negative correlation with the proportion of specific non-loss memory only for the low-TV group (high-TV Chinese group: $r_{Spearman}$ = .25, n = 15, p = .42; low-TV Chinese group: $r_{Spearman}$ = -.63, n = 15; p = .03). These results support the moderation effect of traditional values in both Swiss and Chinese sample. One explanation for why the disruptions in autobiographical memory proposed in *Hypothesis 1* were not observed in the Swiss sample may be due to the moderation effect of their traditional values. Swiss and Chinese bereaved parents with high TV tended to avoid or inhibit loss-related memories when their prolonged grief became severe.

5.2.5 General Discussion

Summary of Findings

To our knowledge, the current study is the first to examine the grief-related disruptions of autobiographical memory in a cross-cultural context between China and Switzerland, concentrating on the specific clinical sample of parents who had lost their child. First, consistent with previous studies, the findings for the whole sample showed that prolonged grief severity was positively associated with retrievals of loss-related memory and negatively associated with specific non-loss-related memory in response to negative cues. However, prolonged grief severity showed no significant association with the retrieval of specific loss-related memory. Hypothesis 1 that proposed a positive association of prolonged grief severity with loss-related memory and a non-significant association with specific loss-related memory was observed in the

Chinese bereaved parents, but not in the Swiss bereaved parents. Second, consistent with hypothesis 2 on cultural differences in the functional avoidance of negative affect, Swiss participants reported a larger proportion of specific loss-related memory than Chinese participants in response to the negative cues. Two national samples showed different associations between prolonged grief severity and memory specificity. Furthermore, the moderation role of personal value orientations was introduced to explain the cultural differences. As expected in hypothesis 3, traditional values showed moderation effects on the associations of prolonged grief severity with the retrieval of loss-related memory and specific non-loss memory, whereas this did not appear for modern values. In particular, previously proposed disruptions in autobiographical memory following bereavement (i.e. prolonged grief severity was associated with preferential retrievals of loss-related memory and reduced specificity in non-loss memory) were observed in the Chinese and Swiss samples with low traditional values. In contrast, these memory characteristics related to grief avoidance were remarkable for Swiss participants with high traditional values, as more severe PG was associated with a lower proportion of loss-related memory for negative cues, but a higher proportion of specific non-loss-related memory for all cues.

Specifically, in the preliminary analysis the effects of culture were observed in the retrieval of specific memory. As Swiss and Chinese cultures are characterized by distinct construal between independent vs. interdependent self, universal memory differences between Chinese and Swiss samples could be expected in memory specificity and memory related to others. Our results showed that Swiss participants reported a higher proportion of specific memory than the Chinese. This finding is consist with previous researches (Jobson, 2011;Jobson & Cheraghi, 2015) and supports the view that individuals from independent cultures consistently provided more specific autobiographical memories than those from interdependent cultures in order to enhance the autonomous self (Wang & Conway, 2004). Furthermore, it is worthwhile to note that higher memory specificity for Swiss bereaved parents was particularly significant in specific loss-related memory in response to negative cues, which is an expected cultural difference related to grief expression (supporting hypothesis 2). Previous study showed that bereaved Swiss parents exhibited more intensive preoccupations with the images and thoughts of the dead offspring than the bereaved Chinese parents (Xiu et al., 2016), which could increase intrusion of specific loss-related memories. Whereas Chinese parents experienced a higher frequency in

accessory grief symptoms such as feelings that life is empty and meaningless, which may relate to abstract ruminative thinking and overgeneral retrieval. This finding indicates that prolonged grief can enhance memory specificity for bereaved persons from the Western cultural.

The main research question of current study is to investigate the role of culture in the competitive mechanism between the memory process of the preoccupation of traumatic memory and the functional avoidance of negative affect. We thus assessed the relationships between prolonged grief severity and autobiographical memory in distinct cultural samples. Recent bereavement studies have indicated that individuals with PG showed preferred accessibility to loss-related memory ("preoccupation of traumatic memory"), and that their PG severity was associated with reduced specificity in non-loss-related memory, which are particular sensible to negative emotions (overgeneral retrieval of the functional avoidance of negative affect) (Boelen et al., 2010a; Eisma et al., 2015; Golden et al., 2007; Maccallum & Bryant, 2010). This was supported by the findings in the whole sample comprising of both Western and Eastern samples of bereaved parents, with PG severity being significantly associated with a greater proportion of loss-related memory and a decreased proportion of specific non-loss-related memory. To date, our study is the first to examine these grief-related memory disruptions in an Eastern cultural sample, which was confirmed in the sample of Chinese bereaved parents. These memory disruptions were also shown in Swiss bereaved parents, but only for individuals with low traditional values. Despite the cultural differences in the moderation role of value orientations (discussed later), these findings provide cross-cultural evidence to the view that prolonged grief could cause potential disruptions of autobiographical memory in terms of memory content and specificity. This further indicates that the underlying psychopathological mechanisms of overgeneral retrieval in autobiographical memory (Williams, 2006), and preoccupation of traumatic memory (Rubin et al., 2008) could maintain working in clinical samples from different cultures.

Additionally, the current study also found some cultural difference in memory disruptions as the result of deliberate grief avoidance, which is relevant to the memory process of a functional avoidance of negative affect. According to the functional avoidance hypothesis for overgeneral retrievals, one would expect higher symptom-levels to coincide with an avoidant retrieval of specific memories related to the loss and a preferential retrieval of specific memories unrelated to the loss, in case of emotional distress. On the contrary, the "immunity hypothesis"

claims that traumatic memories that are difficult to be integrated into autobiographical memory system could be immune from the overgeneral process. The second view was supported by the grief study of Eisma et al. (2015), which found significant associations of prolonged grief with specific non-loss-related memory, rather than specific loss-related memory. The current study argues that the competition between these two memory processes can be better elucidated by considering the role of culture and personal value orientations. In our findings, first, prolonged grief severity was associated with decreased retrievals of specific loss-related memory in response to negative cues for the Swiss sample, but associated with increased retrievals for the Chinese sample. Second, a three-way interaction was shown for prolonged grief, traditional values, and culture to predict loss-related memory. This suggests that the moderation effect of traditional values on the association of prolonged grief and memory indices are different between Swiss and Chinese samples. Specifically, the previously proposed characteristic in memory disruptions were observed in both Chinese and Swiss bereaved parents with low traditional values. In contrast, the Chinese sample with high traditional values showed similar but weaker associations, whereas the Swiss sample with high traditional values showed opposite associations. When grief was severe, they tended to avoid retrieving loss-related memory and divert into retrieval of more specific non-loss-related memories for the negative cues. These results support the findings of Bonanno et al. (2005) that deliberate grief avoidance is associated with the maintenance of symptoms in the Western culture, but not in the Chinese culture. Whereas the finding in the Chinese echoes 'immunity hypothesis'. Furthermore, the Swiss sample exhibited positive associations between prolonged grief severity and the proportion of specific non-loss-related memory in response to positive cues. These findings further echo the rumination framework of grief, in which the processing of a loss through relatively automated mechanisms such as distraction or a shifting attention toward more positive emotional experiences is viewed as a maladaptive form of coping with loss (Bonanno et al., 1995; Keltner & Bonanno, 1997).

The current study investigated the moderation role of personal value orientations in the associations of prolonged grief and autobiographical remembering, which could provide better understanding of different effects of values in relation to mental health. First, Swiss bereaved parents with low or high traditional values differed in the associations between prolonged grief severity and memory retrievals, with for low traditional individuals being preoccupied with or immersed in loss-related memories, with for high traditional individuals being avoiding loss-

related memories and tending to specific non-loss-related memories. A plausible explanation for this result is the negative effect of traditional value on social sharing motivation, as traditional values were related to the belief that the acknowledgement of trauma exposure is not socially acceptable (Maercker et al., 2009). Furthermore, in the opinion of Schwartz (2003), conformity and tradition are viewed as "conservation" values in which individuals share an underlying motivation to avoid threats and anxiety and to preserve the status quo. Therefore, it is speculated that individuals with high traditional values may thus entail less flexible belief system and a tendency towards avoidance. Second, although previous research demonstrated the resilience effect of modern values, the current study did not show any main or moderation effect of modern values on the disruptions of autobiographical memories. These results are consistent previous studies that found that modern values were positively correlated with traditional values, but showed no association with self-perceived social support and was therefore not linked to stress-associated mental health outcomes (Maercker et al., 2009; Müller et al., 2011). As modern values may be related to an independent self, this may explain the finding that modern values are not associated with the social coping mechanism of the grieving and memory process "functional avoidance". Nevertheless, modern values such as self-direction, hedonism and stimulation indicated "openness to change" (Schwartz, 2003) that are related to the construct of hope (Braun-Lewensohn, 2015) and may motivate flexibility and openness towards life experiences. For instance, a case narrative on 'hedonism' in our interview showed that "these years we have traveled a lot, we ate the best food, enjoyed the best things. This can help us escape from the distress. After the death of my child, we have nothing to worry about any longer. I want to have a good time for the elderly life." Therefore, it is recommended that future studies examine the role of modern values in personal growth and adaptive processes in the aftermath of traumatic events.

Theoretical Implications

Our study addressed a broader question "is culture associated with disruptions of autobiographical memory following bereavement?" Prolonged grief disorder is a new psychopathological entity that has recently received intense attention in research and clinical practice (Mancini et al., 2012; Prigerson et al., 2009). Although some recent bereavement model has clarified the role of autobiographical memory in prolonged grief disorder (Boelen et al., 2006; Maccallum & Bryant, 2013), none of these models have considered the socio-interpersonal context of grief coping, which has been highlighted in the development and maintenance of

stress-associated disorders (Jobson, 2009; Maercker & Horn, 2013). Culture refers to a rich complex of meanings, beliefs, practices, symbols, norms and values prevalent among individuals in a society (Fiske, 2002). Researcher in stress-associated disorders raise an interest to investigate how culture influences the psychopathological process, and thus the symptom presentation, etiology, maintenance, and treatment. First, culture provides a complex of historical context, physical environment, and social-economic-politic background that not only associate with similar or different expression of grief (Xiu et al., 2016) and processing of a loss (Bonanno et al., 2005), but also penetrate into the psychopathological functions such as memory system (Jobson et al., 2014), which was examined in bereaved individuals in the current study. Second, apart from the group similarities and differences, culture can exert effects within individual level via cultural components such as beliefs and values. Cultural values and beliefs are reflected in personal values and beliefs, which are associated with an individual's reaction to stressful events and thus affect the appraisal of stress (Aldwin, 2004). For example, Xiu et al. (2016) found that beliefs such as social cynicism and religiosity were associated with grief expression. The current study investigated the role of value orientations in grief psychopathology. Personal values root in the social-economic-politic context and develop in line with the society changing. Values have cognitive and motivational functions that could moderate coping process to stress including social-sharing process such as intention to disclosure and self-perceived social acknowledgement (Maercker et al., 2009), and personal resilience process such as openness to new experiences. Overall, when it refers to the role of culture in mental health or the psychopathological process of prolonged grief, culture not only provides macro and abstract context that holds the underlying mechanisms and nourishes different manifestations, but also permeates into culture-related personal traits via moderating individual coping process.

Limitations

There are several limitations in the current study. First, to guarantee the homogeneity of participants, the study only focused on bereaved parents with inclusion and exclusion criteria in recruitment. The small sample size restricted further analyses and extensive interpretation of results. For example, in the moderation analysis the effect of value orientations may depend on the symptom severity. When the prolonged grief was mild, traditional values appear to be associated with a deteriorating effect for Swiss participants with high traditional values. These participants reported a higher proportion of specific loss-related memory and a lower proportion

of specific non-loss-related memory. Whereas severe prolonged grief could reverse this effect and even led to converse direction. These findings are noteworthy but require further comparison among each subgroup (e.g. 2 [traditional values: low vs. high] × 2 [prolonged grief: low vs. high]). However, the small sample size restricted this analysis. Moreover, although the moderation results portrayed the effect of value between individuals with mild vs. severe grief, it is uncertain to what extent the observed finding are because no formal diagnosis evaluation take place. It would be interesting for further research to retest these results in bereaved individuals meeting criteria for a diagnosis of prolonged grief disorder. In addition, the application of the current findings into other Eastern cultures should be taken in caution, as China previously had the "One-child policy". The majority of Chinese participants are parents who lost their only child. This unique historical and social background may complicate the grieving process and lead to cultural difference due to the institutional system. Nonetheless, Schwartz (2014) claimed that the institutional policies and practices are in relation with what the underlying societal culture promotes, inhibits, or justifies. They also express what underlying cultural value emphases. Individual's' way to interpret and conduct values are situated in social, cultural, ecological and economic contexts (Fischer & Boer, 2016). It is justifiable to speculate that the variant role of values in different cultural groups may reflect the impact of social and cultural backgrounds, including cultural differences in the institutional systems.

Another limitation is that, due to the cross-sectional nature of the data the interactive relationship between grief and autobiographical memory remains unclear. It is therefore difficult to draw a conclusion about whether prolonged grief results in disruptions of autobiographical memory or the non-integrated self-memory system maintains or complicates the grief reaction. Given that autographical memory is one core aspect of psychopathological function of prolonged grief disorder, a longitudinal design would be taken in further study to investigate the potential interactive or causal relationship. For instance, future study could investigate whether the impaired autobiographical memory system is a risk factor for developing prolonged grief disorder and how grief process is associated with individual memory resource. Similarly, the current study investigated the moderating role of value orientations for they were viewed as static culture-related personal traits. However, loss of child can shatter worldviews and coping with the bereavement involves the reconstruction of the worldview (Barrera et al., 2009). Future

study therefore could consider that the prolonged grief can affect personal value orientations, which further moderates grief coping that is related to autobiographical memory.

5.2.6 Conclusion

This investigation adds to our understanding of the role of culture in the psychopathology of prolonged grief. The underlying mechanisms of autobiographical memory system associated with the maintenance and development of prolonged grief may be consistent across cultures, such as a preoccupation of traumatic memories and a functional avoidance of negative affect. However, the consequences of their interplay are situated in the social and cultural contexts, which may nourish different manifestations in the associations between grief severity and memory disruptions. Furthermore, the current study illustrated an avenue in which the effects of personal values orientations facilitated the cultural difference observed at the group level. It suggests incorporating cultural background and culture-related personal traits (e.g. value orientations or social beliefs) into clinical practices of prolonged grief disorder.

5.3 Study 3: "*Personal value orientation and meaning-making narration in grieving parents: a cross-cultural study in China and Switzerland*"

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5.3.1 Abstract

This study investigated the role of personal value orientations and culture in shaping two aspects of prolonged grief (PG) responses: 1) the failure to integrate loss-related memories into autobiographical memory and 2) the severity of maladaptive appraisals. In a newly modified memory task, 30 Chinese and 22 Swiss bereaved parents were asked to narrate some specific memories to reflect their self-evaluation of personal traditional (*conformity*, *benevolence* and *tradition*) and modern values (*self-direction*, *stimulation* and *hedonism*). Bereaved parents were then encouraged to appraise the meaning of each narrated memory event. The self-reported Prolonged Grief Disorder Scale (ref ICD-11) assessed PG severity. Compared with the Swiss sample, the Chinese bereaved parents tended to provide more narrations elaborated with positive appraisals, particularly when narrating non-loss-related memories. Cross-culturally, both Chinese and Swiss bereaved parents with more severe PG provided more narratives of loss-related memories particularly in response to modern values (regardless of appraisal quality). They also provided more appraisals of negative meaning remarkably in response to traditional values. These findings indicate that the severity of PG in bereaved parents is associated with the integration of autobiographical memories and this process is moderated by both modern and traditional values, across different cultures.

Key words: prolonged grief, value orientation, autobiographical memory, narration, meaning, bereaved parents

5.3.2 Introduction

Value orientations are conceptualized as motivational goals that are abstract and context-independent beliefs about desirable modes of conduct or desirable end states (Fischer & Boer, 2016). Researchers in clinical psychology are increasingly interested in the role of personal value orientations as predictors of mental health, and consider them to be personal motivational orientations related to culture (Burri & Maercker, 2014; Guo *et al.*, 2015; Iosifyan *et al.*, 2016; Maercker, 2001; Maercker *et al.*, 2015; Wang *et al.*, 2014; Zimmermann *et al.*, 2014). This originates from the ongoing debate about the role and significance of cultural influence and

cultural factors in the development and maintenance of mental disorders. Two fundamental questions emerge: does culture influence psychopathological mechanisms of mental disorders? What role do value orientations play over an individual's course of coping with stressful life events as a marker of culture? The current study investigated the role of culture and personal value orientations in the grieving process of the death of one's own child. In particular, we concentrates on two crucial components of grieving process: grief-related memory process and meaning reconstruction through meaning-making narrative process (i.e., the quest for the meaning of loss through narrating the death event and related background stories).

Prolonged grief and its psychopathological function in memory process

Prolonged grief (PG) refers to a pattern of grief reactions that extends for an abnormally long period beyond expected social and cultural norms, following the death of a person close to the bereaved (Prigerson *et al.*, 2009). Individuals who suffer from PG manifest persistent and pervasive yearning or longing for the deceased, or a persistent preoccupation with the memories of the deceased. These symptoms are sufficiently severe to cause significant impairment in the person's functioning, such as confusion in self, physical health problems, and dampened social and work functions (Maercker *et al.*, 2013). It is estimated that approximately 10% bereaved individuals meet the criteria of prolonged grief disorder (PGD) after six months of the death (Prigerson *et al.*, 2009). An elevated risk was observed in bereaved parents (McCarthy *et al.*, 2010), whose grief reactions could remain static or deteriorated even after ten years of their child's death (Dyregrov, 1999; Rubin & Shechory-Stahl, 2013).

Some influential grief models indicate that the integration of memories associated with bereavement and the restructuring of autobiographical schemas are central adaptive means of accommodating to a loss (Boelen *et al.*, 2006; Maccallum & Bryant, 2013). Poor elaboration or failed integration of the loss into extant autobiographical knowledge (i.e., personal mental representations of one's self and one's world) involves maladaptive cognitive appraisals and emotion regulation strategies, which can contribute to ongoing intrusion of loss-related memories, persist yearning for the deceased, and maladaptive coping strategies (e.g., avoidance and rumination) (Boelen *et al.*, 2006). Consequently, bereaved person's self-identity is constructed around or entwined with the deceased (Maccallum & Bryant, 2013) such that they recollect loss-related memories as a reference for their self, accompanied by negative appraisals (Maccallum & Bryant, 2008). These suggest that prolonged grief manifests in two dysfunctions of

autobiographical memory: ongoing preoccupations by loss-related memories and maladaptive appraisals for autobiographical memories, which have already been supported by a large body of empirical studies (Gass & Chang, 1989; Maccallum & Bryant, 2008, 2010).

Narration and meaning making following bereavement

The integration of autobiographical memories may be achieved, as every narrative of self-experienced events fits together different experiences of constantly modified past, the present situation and the anticipated future (Rosenthal, 2006). Some researchers emphasize the role of meaning making narration in social sharing since it is a key way of articulating and reinforcing life lessons that emerge from loss (Baddeley & Singer, 2009; Neimeyer *et al.*, 2014; Park, 2010).

Autobiographical reasoning is the evaluative dimension of narration, which is the cognitive approach to make meanings during narrative process (Singer, 2004). Autobiographical reasoning refers to the efforts to making connection between the past and the self, and the evaluation of the connections (McLean & Fournier, 2008). Namely, during the narrative processing of one's own life stories, individuals reason about, interpret, and evaluate their memories (Singer & Bluck, 2001). Meanings are found or made in the forms of inferences, lessons, and thematic insights about the narrative memories (e.g. lessons about how to solve similar problem in the future situation, insights about new understanding or changes in self-identity, relationship and life orientation) (Singer, 2004; Thorne *et al.*, 2004). Previous studies has shown the importance of autobiographical reasoning in relation to well-being (Mansfield *et al.*, 2010) and identity development (McLean & Pratt, 2006). Moreover, for loss and bereavement, a narrative constructivism approach views the reaffirming or reconstructing a world of meaning as the central process in grieving (Neimeyer, 2001; Neimeyer & Calhoun, 2006). The quest for meaning in the life transitions associated with bereavement has been implicated as a key component of the grief experience in bereaved parents (Barrera *et al.*, 2009; Davies, 2004). Making meaning of loss served as one useful predictor to their long-term resilience, well-being, as well as alleviated grief severity (Keesee *et al.*, 2008; Murphy *et al.*, 2003b).

How are meaning-making efforts facilitated through narration? Meaning making benefits from elaborated narrations by focusing the longer-term importance or life lessons of ones' personal loss (Neimeyer, 2004; Neimeyer & Calhoun, 2006). It has been extensively discussed that elaborated narration facilitates integrating memories into ongoing self-knowledge, and powerfully reinforces relevant goals (e.g., Singer & Blagov, 2004). However, meaning making

attempts can fail (Gillies *et al.*, 2014; Gillies *et al.*, 2015). Unsuccessful efforts for meaning making can elevate rumination, which may exacerbate symptoms severity (Sales *et al.*, 2013). As illustrated in a theoretical model of the cognitive coping process of bereavement (Stroebe & Schut, 2010), mourners need to go through oscillations between positive and negative affect and (re)appraisal of both loss-related and restoration-related stressors. Persistent negative appraisals enhances grief, whereas positive reappraisals sustain the coping effort. Thus, elaborated narration with negative meanings would be associated with severe PG as a maladaptive outcome of meaning-making efforts.

Cultural consideration on narration and meaning making in bereaved person

The narrative and meaning reconstruction processes can be conceptualized from a constructionist's perspective (Neimeyer *et al.*, 2014), in which the narrative processes by which meanings are found, appropriated, or assembled are inevitably constructed and sometimes contested in broader cultural contexts. McAdams and McLean (2013) indicated that different cultures nourish different images, themes, and plots for the construction of narrative identity, and individuals within these cultures appropriate, sustain, and modify these narrative forms as they tell their own stories.

One important cultural distinction in relation to narrative and cognitive processes is the natural tendency of analytic-versus-holistic reasoning between Western and Asian people. Training from different social organization and social practices can affect a person's beliefs about the nature of the world and about causality, thus influencing their reasoning about their everyday life events (Nisbett *et al.*, 2001). Westerners tend to engage in context-independent and analytic perceptual processes by focusing on a salient object independently of its context, whereas Asians tend to engage in context-dependent and holistic style of reasoning by attending to the relationship between the object and its context and a preference for explaining and predicting events based on such relationship (Nisbett & Miyamoto, 2004). As autobiographical reasoning is a cognitive process to make connections between events and the self, and meanings are made by reflecting experiences in a long-term or broader context, it is reasonable to expect that holistic-versus-analytic cognitive style can affect meaning-making process. Particularly, Chinese with a context-dependent and holistic tendency may have a preference for elaborating the meanings of events, by the means of finding the relationship between events (relationship

views), accepting the negative and positive aspects (dialectic), and accumulating experience-based knowledge (Nisbett *et al.*, 2001).

Nevertheless, Jobson (2009) states that traumatic memories can override the cultural distinctions in interdependent versus independent orientations in self-construal, as a traumatic event that challenges personal survival will activate an autonomous goal to protect personal safety and to personally control and master the situation, regardless of originally dominant self-orientation. This perspective has been supported by the findings of empirical studies that the differences in self-construal between independent versus interdependent orientations were reflected in everyday memories but not in traumatic memories (Jobson *et al.*, 2014; Jobson & O'Kearney, 2006; Jobson & O'Kearney, 2008). We thus assumed that the psychopathological pathway of "failure to integrate loss-related memories" in prolonged grief might hold similar characteristics in different cultures.

Personal value orientations and mental health

The investigation of the role and significance of value orientations in the development and expression of mental disorder is not new or recent (Agbayani-Siewert *et al.*, 1999). Schwartz' seminal work proposes a universal theory of human values that has been validated across different cultures and ethnicities (Schwartz, 1992; Schwartz, 1994). In mental health research, Maercker *et al.* (2009) have applied Schwartz' model to clinical psychology with simplified categories modern versus traditional values. Traditional values (i.e., conformity, tradition, benevolence, security, and universalism in Schwartz' theory) emphasize collectivism, submissive self-restriction, preservation of traditional practice, protection, and stability; whereas modern values (i.e. self-direction, stimulation, hedonism, achievement, power in Schwartz' theory) present the motivation to pursue personal success and dominance over others or personal gratification.

Recently several researches have attempted to illustrate the cognitive function of values. Although value orientations include cognitive, affective, and behavioral components, values are strongly related with cognitively based traits (Parks-Leduc *et al.*, 2014). Values are organized in personal hierarchies of beliefs about importance and function to help individuals to navigate their social and natural environment, and to guide their attitudes, behaviors and evaluations (Schwartz, 1992). As a timely example, Vecchione *et al.* (2012) found that universalism and group security values underlie the European person's perception of the consequences of immigration. Moreover,

regarding trauma and stress-related disorders, it has been shown that both traditional and modern values predicted the level of posttraumatic stress via mediating self-perceived interpersonal factors (Maercker *et al.*, 2009; Müller *et al.*, 2011). Specifically, increased traditional values were associated with lower self-perception of social acknowledgement as a victim in both German and Chinese crime victims, but associated with higher subjective intention to disclosure in the elderly Swiss who have experienced personal loss or other severe life events. Maercker *et al.* (2015) found that benevolence and hedonism values were associated with perceived social support that can predict mental health in health college students. These studies suggest that, values may work primarily through an appraisal function by perceiving, evaluating and justifying the importance of events or matters, like a lens through which we see the world and evaluate our experiences. Previous studies demonstrate that there is more evidence for traditional values to be negatively associated with mental health, and for modern values associated with resilience against stressful life events (Maercker *et al.*, 2009; Maercker *et al.*, 2015; Müller *et al.*, 2011). Therefore, we expected that traditional and modern values might have different impact in meaning making process associated with prolonged grief.

The current study

The primary purpose of current study is to compare the meaning making narration—based on memory processes— in Chinese and Swiss adults, as examples of Eastern and Western cultures. The two main underlying theoretical references concern the roles of value orientations as markers of different cultural contexts, and the differences in autobiographical or self-defining elaboration of loss-related memories.

A new value-related memory task was developed based on the narrative self-evaluation task (Bauer & Bonanno, 2001) and the self-defining memory task (Blagov & Singer, 2004). This new task asks participants to narrate some autobiographical memories based on self-evaluation of personal value orientations (memory recollection), and then to evaluate the meaning of the recounted event (meaning-making process). In this narrative self-evaluation pattern, individuals evaluate themselves (specifically in terms of their personal values in the current study) based on everyday memories, and make positive and negative appraisals of what they do and who they are. This process may depict current states or dynamic changes in personal values. For the bereaved parents, their narration of self-defining memories encompasses different dimensions of memory elaboration, which are influenced by the severity of prolonged grief and as well situated in

cultural contexts. According to the theoretical backgrounds and previous empirical studies, the hypotheses below explore the role of culture and personal values in the narrative and meaning-making processes, and their relationships with symptoms severity.

Hypothesis 1: The first aim was to investigate cultural differences in the meaning making narration that may originate from implicit holistic versus analytic cognitive tendencies between the Chinese and Swiss people. Given that holistic tendency in Chinese may facilitate a preference for elaborating events in broad context or relatedness, we expected that Chinese bereaved parents would narrate more elaborated memories, i.e. appraisals of the meaning of the event than the Swiss.

Hypothesis 2: According to the psychopathological hypothesis of "failure to integrate loss-related memories" in prolonged grief, one pan-cultural manifestation was expected: bereaved parents' PG severity would be associated with preferential retrievals of loss-related memories, and more maladaptive appraisals of negative meaning during narrative self-evaluation of personal values.

Hypothesis 3: It is assumed that the relationships proposed in *hypothesis 2* would be moderated by the traditional-versus-modern value cues. Specifically, the correlations between PG severity, retrievals of loss-related memory and appraisals of negative meaning would be salient when people narrated their traditional values, but be alleviated in the context of modern values.

5.3.3 Methods

Participants

In a comprehensive cross-cultural project "prolonged grief and autobiographical memory in bereaved parents", middle-aged bereaved parents whose child died from 6 months to 10 years ago were recruited in Beijing and Chengdu of China and the German-speaking region of Switzerland. Inclusion criteria were 6 months post-bereavement as the earliest period required for diagnosis of PGD, up to ten years after the child's death. Middle-aged bereaved parents were recruited between age 35 to 65 years old in case of the degenerative effect on memory function. This study was conducted in accordance with the guidelines of the ethics review board of the University of Zurich. All participants provided written informed consent in advance. Individuals who expressed willingness to participate were invited to an interview including basic personal

data collecting (demographical information and loss-related information), memory tasks and questionnaires.

Of participants who meet the inclusion criteria, totally 30 Chinese and 31 Swiss participated in the Self and Value Defining Memory Task (SVDMT), and completed the basic personal information and questionnaires. Of them, 9 Swiss participants from pilot study who missed the appraisal part of SVDMT were not included in the current study. Therefore, the final sample comprised of 30 bereaved Chinese parents (8 male, age = 55.76 ± 6.80 years old, education in year= 10.57 ± 2.23) whose children died between 1 to 10 years ago (24 male children, dead age = 25.57 ± 6.98 years old, bereavement period = 3.80 ± 2.53 years). The cause of death for Chinese children was one natural accident, 4 human-made accident and 25 illness. Swiss sample comprised of 22 German-speaking bereaved parents (6 male, age = 44.41 ± 8.97 years old, education in year= 16.18 ± 5.18) whose children died between 0.3 to 6 years ago (14 male children, dead age=9.52 ± 8.13 years old, bereavement period = 2.82 ± 1.78). The cause of death for Swiss children was 1 natural accident, 4 human-made accident, 13 illness and 4 suicide. Significant group differences in demographical and loss-related characteristics were found in parent's age ($t = 4.98$, $p < .001$), parent's education in year ($t = 7.46$, $p < .001$) and the deceased child's age ($t = -4.77$, $p < .001$).

Procedure and Measures

Self and Value Defining Memory Task (SVDMT). This task concerns the personal self-defining memories supporting their value system. According to the description of each personal value cue, participants were asked to recall some specific events that help themselves and others to know what were they as a person in relation to their value orientation. They are prompted to narrate in detailed and evaluate the meaning of the event for themselves or their life.

Task procedure: In the main part, participants were asked to (1) narrate some events for each topic value cue; and (2) appraise the meaning of the recounted event. Totally, participants responded to 3 traditional (i.e. *conformity, tradition,* and *benevolence*) and 3 modern (i.e. *stimulation, self-direction* and *hedonism*) values cues. During the task, taking *conformity* as an example, they were told with "*Conformity refers to restraint of actions that may harm others, it's important to follow rules. This may be one of your value, or you have an opposite value. According to what I defined, please tell me some specific event memories in order to let me know what kind of person you are.*" If participants described a general category of events, they were

prompted to try to recall a specific event ("*Can you recount some specific events*?"). After recounting an event, the participants were encourage to appraise the meaning of event ("*How do you appraise this event right now? What does the event say about yourself or your life?*"). For each topic cue, participants could narrate as many as events they could ("*Apart from this event, can you recall another specific event related to this topic words?*"). The cue topics of traditional and modern values were presented in the counterbalancing of ABBA sequence (i.e. conformity, stimulation, self-direction, tradition etc.).

Material processing and coding: Each of the Chinese and German memory narratives was transcribed and separately coded by trained Master's level psychologists (3 German-speaking raters for the Swiss data and 2 Chinese-speaking raters for the Chinese data), according to the same English coding manual. The memories that had inconsistent coding in the initial independent coding procedure were discussed in group and recoded with mutual agreement. First, the memory narratives were deleted if they were unrelated to or misunderstanding of the value orientation. For example, *stimulation* refers to an exciting lifestyle that tend to challenges and risks. However, a narrative about that the experience of losing a child is a stimulation for them do not accord the definition. Second, each memory narratives were coded as being either loss-related or unrelated content (Maccallum & Bryant, 2010). Moreover, the comments and appraisal on narrative event were coded for appraised meaning in terms of elaboration (non-elaborated vs. elaborated memory) (McLean & Thorne, 2001). Of them, elaborated appraisals were further coded as negative and positive meaning respectively. Specifically, one narrative that contained both negative and positive meaning was considered as a maladaptive appraisal and categorized into negative category. Brief descriptions and examples for above coding are depicted in Table 8.

Scores computation: All categories were calculated as ratio scores with a range from 0.0 to 1.0. In preliminary analysis, proportions of memory and appraisal categories for each participant were obtained in terms of loss-related content and kind of appraisals (non-elaborated vs. elaborated). Memories without elaborated appraisals (i.e. unelaborated memories) were calculated for their proportion in subgroups of loss-related versus non-loss-related memories. For example, the ratio of unelaborated loss-related memories was obtained through the number of loss-related memories with non-elaborated appraisals divided by the total number of all narratives for the cues. Moreover, memories with elaborated appraisals were further calculated for their proportions of subcategories in terms of negative meaning and positive meaning. For

example, ratio of negative meaning was obtained through the number of narratives with negative appraisals divided by the total number of the narratives for the cues. All indices were calculated separately for narrated events in response to all value cues, cues of traditional values or cues of modern values, respectively.

ICD-11 Prolonged Grief Disorder Scale (PGDS). This scale is an extended version of the Inventory of Complicated Grief-Revised (ICG) (Prigerson & Jacobs, 2001) and comprises 23 items based on the newly conceptualized diagnosis of prolonged grief disorder in ICD-11 by WHO (Maercker *et al.*, 2013). The participants were requested to describe how often they had felt grief over the past month because of losing their child, using a 5-point scale: 1= *Almost never (less than once a month)*, 2= *Rarely (monthly)*, 3= *Sometimes (weekly)*, 4= *Often (daily)* and 5= *Always (several times a day)*. In this study, we utilized the sum scores to manifest the intensity of prolonged grief.

Statistics

We used R 3.2.2 to execute statistical analysis. To compare the group difference in each memory indices (hypothesis 1), General linear model was utilized to test the effect of culture (Chinese vs. Swiss) without and with controlling group differences in parent's age, parent's education in year and deceased child's age. To examine hypothesis 2, partial *Spearman* correlation analysis with controlling for background variables was conducted to obtain the associations of PG severity with memory indices in response to all cues, and to traditional and modern value cues respectively. Finally, to test the moderation effects of culture and personal value orientations (hypothesis 3), Generalized estimating equations analyses that took context cues of value orientations as a repeated measure were carried out to examining the main and interaction effects among prolonged grief severity, culture, and value contexts (value orientation: traditional vs. modern values), with covariates of group differences. In order to minimize any problems of multicollinearity, all the variables were mean centered prior to moderation analysis.

5.3.4 Results

Cultural comparison of the SVDM indices

The SVDM indices for the two samples are given in Table 9 for all value cues. Both samples narrated only small proportions of loss-related memory (Ratio $_{Chinese}$ = .15, Ratio $_{Swiss}$ =.17) compared to memories with other content. Main effects of culture were shown in the proportions of elaborated memories. As expected in hypothesis 1, Chinese narrated a significantly larger

Table 8. Coding and examples for self and value defining memory (all examples are from Chinese participants)

Category	Description	Example
Loss-related memories	Value-related memories associated with the child's death or memories relating to an aspect of the grief experience related to child	***Conformity***: "Actually we planned to have three babies. However, only one child was allowed by the government. In the end, we conformed the willingness of government. As the result, I have no child. I will be alone when getting older, without any supports. **[Appraisal]** I think this is one example that I have no my definite views. No matter what situation it was, I should insist on myself. The current outcomes, actually, it is I who made it, why I had surrendered to the power! "
Elaborated memories		
A1.Non-elaborated memories	(1) Pure narratives of events without extension. (In some case, participants expressed no comments or refused to appraise the recounted event) (2) makes no interpretative statement about the larger significance or meaning in general or individually	***Benevolence***: "My aunt is ill and stays in hospital every day. I always go to take care of her. She only has one child who is too busy working to take care of her mother. ... **[Appraisal]** I am very glad. I think I should do this."
A2.Elaborated memories	Narratives with elaborated meaning that has been found or made by learning a specific lesson, or/and reflecting the larger implications of the event to	***Benevolence*****:** "Once I met a young person who begged me for 10 Yuan. I asked what happened to him. Without doubting that he was cheating me, I

	sense of self and belief system.	took him to a restaurant. I paid the bill and gave him some money to buy ticket back home. **[Appraisal]** The money of the meal is small amount for me, but from which he could experience some warm love from others. 'Be friendly to others, never do any bad deed', this is my principle of being a man."
B1. Negative meaning	Negative (re)appraisals such as catastrophic misinterpretations, pessimistic attitude, negative lessons learned, and negative beliefs.	*The example for "loss-related memories" applies to this category.*
B2. Positive meaning	*Positive (re)appraisals such as* optimistic attitudes, valuable lesson learned, and positive views or beliefs.	*The Example given for "elaborated memories" applies to this category.*

proportion of elaborated non-loss memory than the Swiss sample (effect size: Cohen's d = 2.50), whereas they had no difference in the proportion of elaborated loss-related memory. In addition, the Chinese sample exhibited a larger proportion of positive meanings than Swiss sample (Cohen's d = 2.0), but not for negative meaning. All these findings were maintained after controlling for group difference variables (i.e. parent's age, parent's education in year, and deceased child's age).

Table 9. Mean, standard deviation and group difference for the prolonged grief severity and SVDMT indices for all value cues

	Mean		**SD**		**Group difference (*F*)**	
	Chinese	Swiss	Chinese	Swiss	Without covariates	With covariates
Prolonged grief	63.93	53.04	22.40	11.80	4.31*	.02
Loss-related memories	.15	.17	.17	.17	.22	.17
Elaborated loss-reated memories	.11	.06	.14	.09	2.46	2.13
Elaborated non-loss memories	.56	.11	.23	.11	74.88**	36.21**
Negative meaning	.14	.07	.15	.11	3.78	1.58
Positive meaning	.44	.09	.23	.09	45.53**	25.61**

Note: SVDMT indices are ratios ranging from 0.0 to 1.0. Group difference was tested the main effect of culture in General linear model. Covariates includes significant group differences in parent's age and education in year, and dead child's age. * $p < .05$, ** $p < .001$.

Associations between PG severity and SVDM indices

Table 10 shows the correlations between PG severity and SVDM indices with controlling for variables that differ between the ethnic groups. Hypothesis 2 was supported in the findings in the response to all cues. For both samples, PG severity was positively correlated with the larger proportions of loss-related memory (however, only significant for Chinese sample: p = .04) and negative meanings. In addition, the prolonged grief severity of Swiss sample was significantly positively correlated with larger proportions of elaborated narrations for both loss-related and non-loss memories, whereas no significant associations were shown for the Chinese sample.

Table 10 further illustrates these associations in different value contexts (hypothesis 3). For both Chinese and Swiss samples, the correlation between the higher level of PG severity and larger proportion of loss-related memory was observed in the context of modern values, whereas no correlation were in the context of traditional values. The positive associations between PG severity and negative meaning were only significantly in the context of traditional values. However, these national samples showed differences in the elaborated narrations. The Swiss participants with more severe PG provided larger proportions of elaborated narrations in the contexts of both modern and traditional values, which were particularly significant for the loss-related memory. Whereas, for the Chinese participants, only a significantly negative association between PG severity and elaborated non-loss memory was found in the context of modern values. Moreover, no significant result was found in the correlations with positive meaning for both samples.

Table 10. Spearman correlations of prolonged grief severity with memory indices for all cues, traditional or modern value cues, with controlling for parent's age, parent's education, and the child's age at death

	Loss-related memory	Elaborated loss-related memory	Elaborated non-loss memory	Negative meaning	Positive meaning
Chinese sample					
All value cues	.39*	.14	-.26	.49**	-.16
Traditional value cues	-.05	-.19	.04	.50**	-.15
Modern value cues	.40*	.26	-.42*	.31	-.17
Swiss sample					
All value cues	.23	.59**	.46*	.65**	.29
Traditional value cues	.07	.48*	.42	.61**	.18
Modern value cues	.33	.59**	.22	.31	.28

Note: *p< .05, **P< .01, *** p<.001

Moderation by culture and personal value orientation

Table 11 demonstrates the main and interaction effects among culture, PG severity and value orientation. We mainly report the findings of interaction effect to illustrate the moderation effects of culture and personal value orientation. First, culture has no interaction with prolonged

grief severity to predict the proportion of loss-related memory (Wald x^2 = .35, p = .56) and negative meaning (Wald x^2 = 2.05, p = .15), supporting the cultural similarities proposed by hypothesis 2. Significant interactions between PG severity and culture were shown in proportions of elaborated loss-related (Wald x^2 = 4.83, p = .03) and elaborated non-loss memory (Wald x^2 = 21.38, p < .001) and positive meaning (Wald x^2 = 5.87, p = .02), indicating the moderation effects of culture in the associations of symptom severity with elaborated narrations for both loss-related and non-loss memories with positive meaning. Specifically, compared with Chinese sample, Swiss sample showed larger associations of PG severity with elaborate loss-related (Wald x^2 = 3.40, p = .07) and elaborated non-loss memories (Wald x^2 = 15.88, p < .001).

Table 11. Testing the moderation effects of culture (Chinese vs. Swiss) and personal value orientation (modern vs. traditional values) in the associations between prolonged grief severity and memory indices (coefficient beta)

	Loss-related memory	Elaborated loss-related memory	Elaborated non-loss memory	Negative meaning	Positive meaning
Covariates					
Parent's age	-.22	-.§22	.23	.08	.17
Dead child's age	.24	.15	-.14	-.01	-.23
Parent's education	.06	.11	.24***	.23*	.20**
Main effects					
Culture	.25	-.39	-1.60***	-.36	-1.58***
Prolonged grief	.34	.23*	-.30	.31**	-.18
Value orientation	-.29*	.41**	.01	-.20	.03
Interactions					
Prolonged grief × Culture	.27	.53*	.54***	.41	.33*
Prolonged grief × Value	-.36*	-.38**	.31*	-.06	.04
Prolonged grief × Value × Culture	-.08	.01	-.20	-.10	.10

Note: *p< .05, **P< .01, *** p<.001

Regarding the moderation role of value orientation, an interaction between value orientation and PG severity was shown in the proportion of loss-related memory (Wald x^2 = 5.27,

p = .02), but no in the negative meaning (Wald x^2 = .40, p = .53), which does not supports hypothesis 3. Value orientations interacted with PG severity to predict to elaborated loss-related (Wald x^2 = 7.98, p < .01) and non-loss memories (Wald x^2 = 4.37, p = .04). Specifically, to compare these associations between two contexts of traditional-versus-modern value cues, the association between PG severity with elaborated loss-related memories was significantly larger in response to modern value cues (Wald x^2 = 3.74, p = .05), whereas the association between PG severity with elaborated non-loss memories was significantly larger in response to traditional value cues (Wald x^2 = 4.64, p = .03). In addition, no significant result of three-way interaction was found, indicating that the moderation of value orientation does not differ between different cultures.

5.3.5 Discussion

Taking personal value orientations as a marker of culture at the individual level, the present study investigated Chinese and Swiss bereaved parents' meaning-making process for their self-defining memories with relation to personal modern-versus-traditional values. First, as expected in hypothesis 1, compared with the Swiss sample, the Chinese sample exhibited a tendency to provide more elaborated non-loss memories with positive meaning to reflect their personal values. Second, consistent with the psychopathological hypothesis "failure to integrate loss-related memories" in prolonged grief (Boelen *et al.*, 2006), both Chinese and Swiss bereaved parents with more severe PG provided more narratives of loss-related memories and negative meanings. As expected, no moderation effects of culture were found in this characteristic, supporting the assumed cultural similarities in hypothesis 2. Furthermore, when comparing these characteristic manifestations associated with different value cues (hypothesis 3), the associations between PG severity and loss-related memories was strong in response to modern value cues, whereas the association between PG severity and negative meaning was only significant for self-defining memories in response to traditional value cues. Nevertheless, when considering the moderation of moderation of value orientation, this was observed in the association of PG severity with narrations of loss-related memories, but not in the association with negative meanings.

Cultural differences in narration

The finding that Chinese sample provided more elaborated narration than the Swiss sample is consistent with the proposal of holistic style of reasoning in the Chinese people (Nisbett *et al.*,

2001). No correlation was found between symptom severity and elaboration narration for the Chinese bereaved parents. Thus, this tendency can be attributed to Chinese culture, instead of symptom severity. Furthermore, their tendency showed two features. First, elevated elaboration in the Chinese bereaved was observed in non-loss memory, rather than loss-related memory. This finding provides an extra support to hypothesis 2. Traumatic memories that are usually accompanied by intensive emotion and are central to the person's life story and identity of self (Rubin *et al.*, 2008) can override the influence of cultural differences in the framework of self and cognitive style. Second, Chinese participants prefer to offer more positive meanings with relation to their value orientations. One plausible exploration is that Chinese people are experiencing an evolution of modern and traditional values due to the rapid development of society (Heim *et al.*, in press) and may exhibit strong willingness to clarify or reaffirm personal values during self-evaluation. Chinese pronouncedly tend to provide positive appraisals to their own behaviors, and judge others in a negative manner (Zhai & Qu, 2001), e.g. to think in terms of the "Good-person" so that they scored highly on some values such as integrity, self-support/respect, and collective or public interest (Jin *et al.*, 2009).

Prolonged grief severity and cross-cultural similarities

The second main finding is the cultural similarity that severity of prolonged grief was associated with retrievals of loss-related memories and the negative appraisal of self-defining memories with relation to personal values. These findings indicate, although cultural differences in Western-versus-Eastern tendency in cognitive reasoning of memories (i.e. holistic versus analytic tendency), the psychopathological function underlying prolonged grief maintains for bereaved parents from different cultures.

Although elaborating narratives has been viewed as an approach to foster positive personal transformation (Neimeyer, 2004), the (mal)adaptive outcomes rely on the valence of meanings found or made. Our results showed that both Chinese and Swiss bereaved parents with severe prolonged grief appraised their memories with more negative meaning, whereas positive meaning was not associated with alleviation in symptom severity. Stroebe and Schut (2010) claimed that both positive and negative affect/appraisal are understood as an integral part of coping process. Although positive appraisals could sustain the coping efforts, grieving may be neglected if positive states are maintained relentlessly. Nevertheless, negative appraisals of one's life story were found to predict long-term poor emotion regulation (Cox & McAdams, 2014).

One potential pathological cognitive process conceptualized by Boelen *et al.* (2006) is that bereavement could cause negative global beliefs and catastrophic misinterpretations, which directly generate negative emotions and interfere with the integration of the autobiographical database, such as meaning-making process in the current study.

In addition, these grief-related manifestations emerged when bereaved parents operated self-evaluations of personal value orientations, indicating that their personal meaning system of value orientations may have been affected by bereavement. Previous studies showed that traumatic life events could challenge, shatter or shift one person's meaning system, such as self-identity, assumptive worldviews, beliefs, life goals and purpose (Gillies & Neimeyer, 2006; Janoff-Bulman, 1989; Park, 2010). Below are some examples that briefly demonstrate how bereaved person's values are reaffirmed or reconstructed in the light of assimilation and accommodation processes (Park, 2010). In the SVDMT, memories content narrative depicts the maintenance or transitions of personal values. Specifically, the process of assimilating autobiographical memories into prior value systems can be manifested in maintenance (e.g. "*More bereaved parents choose sea-burial, but I cannot accept this new thing. I would like to respect the tradition so that I bought a grave for my son. I feel peaceful when I did this. I think I have done everything I can do for him*") and strengthen of their prior values (e.g. "*I am a really independent woman. Even now, after my son died, I have rarely relied on my husband, and I always try to find my own ways to solve problems. I feel peaceful about this*"). Whereas, the process of accommodation into new value meaning system can start from doubting (e.g. "*I was quite interested in stimulated activities. However, the death of my child makes me feel that everything is meaningfulness*"), questioning (e.g. "*I conformed to the One-child Police. We planned to have three babies. It is me who made it, why I had surrendered to the power?*"), or conflicting current values ("*After the death of my son, I began to pursue the pleasure, shopping, eating, traveling…These are superficial, my heart is painful. I have a strong hatred to money and hedonism*"), and consequently come into contamination ("*I'm a benevolent person. After experiencing the death of my son, I have absolutely changed. I always gave money to the homeless people in the street, and helped the poor people. But bad thing happens to good people. I will never do it again*") or redemption (e.g. "*I'm the only person in my ward who survived from the surgery. I regard it as a kind of motivation. When I open eyes, I would really begin to enjoy the life. I will try my utmost to contribute to my family*").

Value orientation types and outcomes

The third main finding is that above relationship between symptom severity and grieving process differentiates between traditional vs. modern values. First, parents with more severe prolonged grief tended to retrieve more loss-related memories in the response to modern values, indicating modern values entailed more involvement of processing grief-related memories than traditional values when their grief is severe. However, the associations of prolonged grief severity with negative meanings was not as strong for modern value cues as for traditional values. That is to say, the modern values seem to facilitate the integration process of grief-related memories, whereas traditional values trigger more maladaptive appraisals. For example, some of participants narrated that they attempted to adapt to new life situations by accepting or reconstructing modern values that are related to positive coping strategies such as being more self-independent and pursuing personal gratification (an example for hedonism value: "*these years we have traveled a lot, we ate the best food, enjoyed the best things. This can help us escape from the distress. After the death of my child, we have nothing to worry about any longer. I want to have a good time for the elderly life*").

The finding for both samples that symptom severity was associated with negative meaning in the context of traditional values suggests that these values might have a detrimental (Maercker *et al.*, 2009; Müller *et al.*, 2011). For both Chinese and Swiss cultures, the death of a child is against the expectations of traditional culture that emphasizes the central family structure, preservation of traditional practice, stability, conformity with rules and social expectations. Survivors thus confronted a situation whether their traumatic experiences and grieving process was socially acknowledged (Klass, 2001). Within individuals, the social acknowledgement may relate to a compassionate self-awareness that one's bereavement experience and own pains are understandable and legitimate judged by existing values and beliefs system (Neimeyer & Cacciatore, 2015). Therefore, bereaved parents might confront challenges from their traditional cultural values and feel unacceptable or unacknowledged by pre-existing personal traditional values, which could result in maladaptive appraisals and consequently associate with severe prolonged grief.

Limitations

There are some limitations for this study. First, the study applied cross-sectional methodology. Thus, when prolonged grief severity was found to be associated with the narrative

and meaning of self-defining memories in response to one particular value, two potential explanations could be deluded: this particular value might have a strong role in the grieving process of autobiographical memories and meaning-making attempts; or this value might have confronted intensive challenges and exhibit high probability to be reconstructed over grieving course. Although we assumed that value might have been threaten in the wake of bereavement, our task cannot clearly identify between the moderation role of stable values and the changes of flexible values because of the cross-sectional nature of data. These should be not only discussed within one specific social and cultural contexts, but also need to be examined in a prospective and longitudinal study. Second, personal value orientations are also considered as abstract motivations that explain attitudes and behaviors (Schwartz, 2003). This study investigated the appraisal function of value in meaning-making process without consideration their role in motivation system. As the motivational function of values is related to coping strategies (Iosifyan *et al.*, 2016), other pathways of value orientations towards psychopathology of prolonged grief disorder are possible and have to be explored in further studies. More basically, the two samples in the present study had differences in some demographic variables. However, further analysis on the contributions from background differences was limited by the small sample size.

Practical implications

Multiculturalism in psychotherapy has been a major focus in the last decade. Within the constraints of these limitations, the findings of the current study suggest a number of implications for practice. First and foremost, the study showed that the psychopathological process "failure to integrate loss-related memories" in prolonged grief seems to override the Eastern and Western cultural backgrounds, indicating that grief interventions that focus on grieving processes of autobiographical memory integration and meaning reconstruction may be advisable and effective for bereaved persons from different cultures. Meaning-orientation narrations and negative cognitive appraisals seem to be important predictors of prolonged grief severity, intervention may be developed to help individuals to cope with negative cognitive appraisals of death event and "back stories", and to reconstruct negative meanings during narrative process. Furthermore, due to the holistic style of reasoning, Chinese people have a tendency towards elaborated narrations with positive appraisals to reflect experiences in terms of broader context and general meaning, which can be also observed in the Swiss persons with severe prolonged grief. One implication for the further study is to investigate whether analytic

reasoning has a potential to facilitate grieving process of loss-related memory. For instance, interventions that concern with strengthening specific retrieval of autobiographical memories have showed effects on improvement of mental health (Neshat-Doost *et al.*, 2012).

In addition, the findings of cultural differences emphasize the importance of ecological effects and encourage developing cultural-specific grief psychotherapy with considerations of individual differences that unfold with social and cultural contexts. One of crucial culture-related personal utilities is personal value orientation. Our findings indicate that personal values may be reaffirmed or reconstructed over the course of grieving process. It would be helpful to assign an intervention to assist bereave persons to clarify and rebuild value system. Specifically, an intervention that addresses the conflicts in traditional values may be beneficial to their self-acceptance and perception of social supports, and modulate maladaptive appraisals during their meaning reconstruction. Personal growth in modern values such as self-direction and enjoying personal life may provide resilience to adapt with the bereavement. Therefore, one practical implication could be to facilitate narrations of grieving clients to reconstruct negative appraisals that center on traditional values in relation to the hardship of the personal loss.

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APPENDIX A

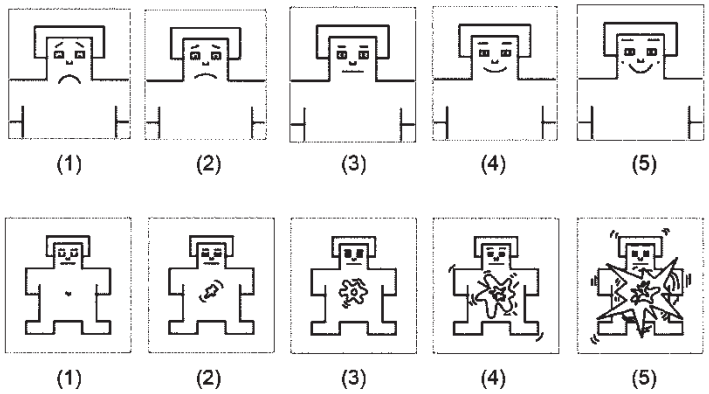
Autobiographical Memory Task (AMT)

In the following task, I will ask you to recall and recount some life events. I will provide you with some cue words. Your task will be to recount some memories that come to your mind. The event may happen recently (e.g. yesterday, last week) or a long time ago. It may be an important event, or a trivial event. Please note that:

(1) Each memory should be of a specific event that happened at a particular time on a particular day. For example, if it presents "good" (present this card) – it would not be appropriate to say "I always enjoy a good party" because it does not depict a specific event. Instead, it would be appropriate to say "I had a good time at Jane's party" because that is a real event.

(2) Please respond as soon as possible with the first memory that comes to mind. Please do not reject any memory.

(3) After you narrate each memory, I will show you this card and please tell me "how is the recalled event making you feel at the moment?" by selecting which cartoon describes a similar emotion to yours:



The first line of picture shows how positive or negative the memory makes you feel at the moment: the left is negative, and the right is positive. The second line of picture shows how excited or arousal the memory makes you feel at the moment: the left is "not at all", and the right is "extremely".

(4) Once you have completed one cue word, you will have a short break. You can close your eyes, clear your mind or think of another things.

Now, let me do some practices in advance.

→ Pick up a practice word (e.g. book, bread, patient, and cautious) and present it to the participant: please tell me a specific memory as soon as possible!

- **If the memory is not specific memory**: Can you tell me about a specific event or time that comes to your mind?
- **If the participant can't recall a memory within 30 seconds**: Take easy, please tell me the first memory that comes to mind, do not reject the memories

→ After participants tell a memory, present the SAM rating picture: please tell me how the recalled event makes you feel at the moment by illustrated in this cartoon pictures.

Now, please close your eyes, clear your mind and think of another memories. **(around 20 seconds)**

→ Repeat practice for three times, make sure that the participant has already been familiar with the procedure.

Are you clear with the procedure? Do you have any question about this task?

Great! Next, let us start the formal task. Once again, please tell me some specific events with you first memory.

***Procedure for interviewer*:**

- Present the card about 1m away from and in front of the participant, and ask "*please tell me a specific memory according to this word I show you now.*"
- For each word, the participant have ***60 seconds*** for preparing to report a memory. If s/he finds difficult to recall a memory, change into a new cue word.
- Present the emotion-rating card, and ask "*how is the recalled event making you feel at the moment? Please point it out in this card*"
- Once s/he has completed one word, give the participant a short break for 20 seconds.
- Make notes about the rated score for each recounted memory.

Scoring card

	Word	Emotional valence					Emotional arousal				
01	**safe**	①	②	③	④	⑤	①	②	③	④	⑤
02	**sad**	①	②	③	④	⑤	①	②	③	④	⑤
03	**guilt**	①	②	③	④	⑤	①	②	③	④	⑤
04	**honest**	①	②	③	④	⑤	①	②	③	④	⑤
05	**brave**	①	②	③	④	⑤	①	②	③	④	⑤
06	**hopeless**	①	②	③	④	⑤	①	②	③	④	⑤
07	**lonely**	①	②	③	④	⑤	①	②	③	④	⑤
08	**relax**	①	②	③	④	⑤	①	②	③	④	⑤
09	**happy**	①	②	③	④	⑤	①	②	③	④	⑤
10	**fear**	①	②	③	④	⑤	①	②	③	④	⑤

(Note. the cue words have been randomly arranged according to the counterbalance of “ABBA” sequence.)

APPENDIX B

Self and Value Defining Memory Task (SVDMT)

In the following task, please continue to recall and recount your life events. Different from the previous one, I will provide you with some topic-words that may be similar to your own personality characteristic or values. Please recount some memories that come to your mind following the presented cue word. It will not be important, if the events were crucial to you or an everyday experience. These memories can be positive or negative or both. You may have thought about it frequently, because they help yourself and others to know what are you as a person. For each cue word, please describe briefly such specific memories—as many as you can. These short descriptions can mention when it happened and what happened; if any, other persons that were involved in addition to you; and what the event says about yourself or how you conduct your life. It will not be time-limited. You can elaborately think of them before you tell me. After each narration, please also rate your emotion in the picture by "how is the recalled event making you feel at the moment?"

Here is an example for the exemplary word "autonomous":

The first one is "When I was 18 years, I left home and went to another town to start my first professional training. I left my family and stayed alone in a rooming house. It was the first time in my life being independent from my parents"

The second one is "When I married, I did not ask my parents to organize for me but organized it together with my future husband myself. I wanted to organize this important event the way we liked it. I wanted to become a person who is responsible to the family".

A non-helpful list of memories would be only with headlines such as job, marriage, raising children …

Are you clear with the procedure? Do you have any question about this task?

***Attention, interviewer*:**

- Present the card about 1m away from and in front of the participant
- For each cue word, it is not time-limited to recall.
- Once s/he has completed one word, give participants a short break.
- Make notes about how the memory is rated.

Cue-word 1: **Conformity**										
→Instruction: *"Conformity", refers to restraint of actions that may harm others, it is important to follow rules. This may be one of your characteristic, or you have an opposite value. According to what I defined, please tell me some specific event memories in order to let me know what kind of person you are.*										
→After participants recount a specific event, ask: *How do you evaluate this event right now? What does the event say about yourself or your life?*										
→At the end of each memory, present the SAM rating picture to the participant, and ask: *please rate how is the recalled event making you feel at the moment?*										
	Emotional valence					**Emotional arousal**				
Memory 1	①	②	③	④	⑤	①	②	③	④	⑤
→ Ask this question twice, and wait for at least 1 minutes between each time: *Apart from this event, can you recall another specific event related this topic words?*										
Memory 2	①	②	③	④	⑤	①	②	③	④	⑤
Memory 3	①	②	③	④	⑤	①	②	③	④	⑤

Cue-word 2: **Stimulation**										
→Instruction: *"Stimulation", refers to interests in challenges and risks, it is important to have an excited life. This may be one of your characteristic, or you have an opposite value. According to what I defined, please tell me some specific event memories in order to let me know what kind of person you are.*										
→After participants recount a specific event, ask: *How do you evaluate this event right now? What does the event say about yourself or your life?*										
→ At the end of each memory, present the SAM rating picture to the participant, and ask: *please rate how is the recalled event making you feel at the moment?*										
	Emotional valence					**Emotional arousal**				
Memory 1	①	②	③	④	⑤	①	②	③	④	⑤
→ Ask this question twice, and wait for at least 1 minutes between each time: *Apart from this event, can you recall another specific events related this topic words?*										
Memory 2	①	②	③	④	⑤	①	②	③	④	⑤
Memory 3	①	②	③	④	⑤	①	②	③	④	⑤

Cue-word 3: **Self-direction**										
→Instruction: *"Self-direction", refers to independence of thoughts and activity, it is important to be curious and open to everything. This may be one of your characteristic, or you have an opposite value. According to what I defined, please tell me some specific event memories in order to let me know what kind of person you are.*										
→After participants recount a specific event, ask: *How do you evaluate this event right now? What does the event say about yourself or your life?*										
→ At the end of each memory, present the SAM rating picture to the participant, and ask: *please rate how is the recalled event making you feel at the moment?*										
	Emotional valence					**Emotional arousal**				
Memory 1	①	②	③	④	⑤	①	②	③	④	⑤
→ Ask this question twice, and wait for at least 1 minutes between each time: *Apart from this event, can you recall another specific event related this topic words?*										
Memory 2	①	②	③	④	⑤	①	②	③	④	⑤
Memory 3	①	②	③	④	⑤	①	②	③	④	⑤

Cue-word 4: **Tradition**										
→Instruction: *"Tradition", refers to respect and commitment to the traditional cultural customs and idea, it is important to do things the way learned from your family. This may be one of your characteristic, or you have an opposite value. According to what I defined, please tell me some specific event memories in order to let me know what kind of person you are.*										
→After participants recount a specific event, ask: *How do you evaluate this event right now? What does the event say about yourself or your life?*										
→ At the end of each memory, present the SAM rating picture to the participant, and ask: *please rate how is the recalled event making you feel at the moment?*										
	Emotional valence					**Emotional arousal**				
Memory 1	①	②	③	④	⑤	①	②	③	④	⑤
→ Ask this question twice, and wait for at least 1 minutes between each time: *Apart from this event, can you recall another specific event related this topic words?*										
Memory 2	①	②	③	④	⑤	①	②	③	④	⑤
Memory 3	①	②	③	④	⑤	①	②	③	④	⑤

Cue-word 5: **Benevolence**										
→Instruction: *"Benevolence", refers to always will to help around people, it is important to enhance the welfare of close people. This may be one of your characteristic, or you have an opposite value. According to what I defined, please tell me some specific event memories in order to let me know what kind of person you are.*										
→After participants recount a specific event, ask: *How do you evaluate this event right now? What does the event say about yourself or your life?*										
→ At the end of each memory, present the SAM rating picture to the participant, and ask: *please rate how is the recalled event making you feel at the moment?*										
	Emotional valence					**Emotional arousal**				
Memory 1	①	②	③	④	⑤	①	②	③	④	⑤
→ Ask this question twice, and wait for at least 1 minutes between each time: *Apart from this event, can you recall another specific event related this topic words?*										
Memory 2	①	②	③	④	⑤	①	②	③	④	⑤
Memory 3	①	②	③	④	⑤	①	②	③	④	⑤

Cue-word 6: **Hedonism**										
→Instruction: *"Hedonism", refers to enjoy life, it is important to have a good time. . This may be one of your characteristic, or you have an opposite value. According to what I defined, please tell me some specific event memories in order to let me know what kind of person you are.*										
→After participants recount a specific event, ask: *How do you evaluate this event right now? What does the event say about yourself or your life?*										
→ At the end of each memory, present the SAM rating picture to the participant, and ask: *please rate how is the recalled event making you feel at the moment?*										
	Emotional valence					**Emotional arousal**				
Memory 1	①	②	③	④	⑤	①	②	③	④	⑤
→ Ask this question twice, and wait for at least 1 minutes between each time: *Apart from this event, can you recall another specific event related this topic words?*										
Memory 2	①	②	③	④	⑤	①	②	③	④	⑤

APPENDIX C

Scoring Manual for Autobiographical Memories in Grief Study

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Part I Autobiographical Memory Task (AMT)

Scoring Table for Autobiographical Memory Task

Variables	Type		Scoring Number
Specificity	Specific narrative		1
	Non-specific narratives	Episodic	2
		Generic	3
Grief-realted content	Narratives related to the deceased	Loss	1
		Person	2
	Narratives unrelated to the deceased	Others	3

Variable 1: Specificity of Memory Narrative

This part is modified from the coding manual "*Classification System and Scoring Manual for Self-defining Autobiographical Memories*" by Singer and Blagov (2000).

Based on the degree of overgenerality, narratives are grouped into three categories: specific narratives, episodic narratives and generic narratives. Otherwise, based on the extent of specificity, narratives can be group into two categories: specific narrative and non-specific (or general) narrative. The non-specific narrative covers both episodic and generic narratives.

Please code the scripts according to the three-level system.

1. Specific narrative

1.1 Scoring number: 1

1.2 Criteria

A specific narrative has at least one single-event statement. A single-event statement is a sentence in which the attention of the participants is clearly focused upon a happening that meets the following criteria:

Criterion 1: Unique occurrence.

The participant's attention is focused on something that happened on a particular day that ***can possibly be identified by its date and time***.

Criterion 2: Brief duration of less than one day.

It is clear from the narrative that the single-event statement concerns with the happenings of ***less than one day, or, in some cases, a night and the following morning*** (i.e., the action of

the single-event statement is encapsulated within a 24-hour period). The brevity of the happening also means that it is perceived as ***an uninterrupted unity.***

2. Non-specific/general narratives (Episodic and Generic):

The non-specific narratives (or general narratives) consist of episodic narratives and generic narratives. Please code "2" for episodic narratives and "3" for generic narratives.

2.1 Episodic narratives:

An episodic narrative refers to two types of narratives:

(1) A single specific event that lasted more than one day (24 hours);

(2) A series of events with a same topic (or follow a story line). How to differentiate episodic event from a generic event? First, an episodic narrative refers to a series of events that happened in ***progressive or causal relationship***. Second, these pieces of events happened with a same topic or following a story line, which can be regarded as a unity.

First, episodic narratives lack any single-event statements of the kind that was described previously. ***The span is more than a day or with unclear duration*** (for example, junior year in high school, last summer's vacation, a period of unemployment). Second, most of time an episodic narrative is a series of events that ***may be a unity (such as a vacation trip) or may be composed of several related general events that develop into a story line.*** Moreover, if they do mention something happening on a particular day, then it is only as a part of a developing narrative beyond itself, and it is also deprived of imaginative detail, speech, or a statement about strong emotion, importance, or a singling-out statement about the time. The narrative as a whole may have such statements, but they would ***pertain to a general event with a length of over a day or with unclear duration. Overall, the episodic narrative is a generalized narrative of sequential events that fit into a single lengthy timeframe.***

2.2 Generic narratives:

The generic narratives do not involve a specific single event or a series of events. Instead, these memories are general narratives for equivalent or multiple events that contain the same or similar characters, settings, happenings, and emotions. For example, "*I'm a traditional person and always obey my parents, for example, go to college, find a girlfriend and work*", "*Each time I watch this movie, I am deeply touched*", "*All summer vacations throughout high school I found a part-time job*". These examples are neither single-event statements that occurred in a specific

time or place, nor a specific series of events within a period and same topic. The participants blend or fuse these events with the same characteristics or content together, narrate them in a general way, and frequently used time lags such as “all, every, each, whenever, always”.

The generic blend of events that comprises the generic memory narrative may consist of events that would otherwise meet the criteria for either specific or episodic events. The narrative may contain an event that stands out as a good example of what all other events in the blend were like, yet the focus remains on the abstraction of repeated experience. In that case, these narratives can still be coded as “generic narratives”. However, one exception is when a specific situation or one particular time may be mentioned by the participant as an example of how all the other similar events happened. A complex memory narrative may contain a generic portion but also a portion in which some specific or episodic event is told that is not in itself part of the generic blend of events. In this case, the memory is categorized according to 1.3.3 as a type of specific or episodic narratives.

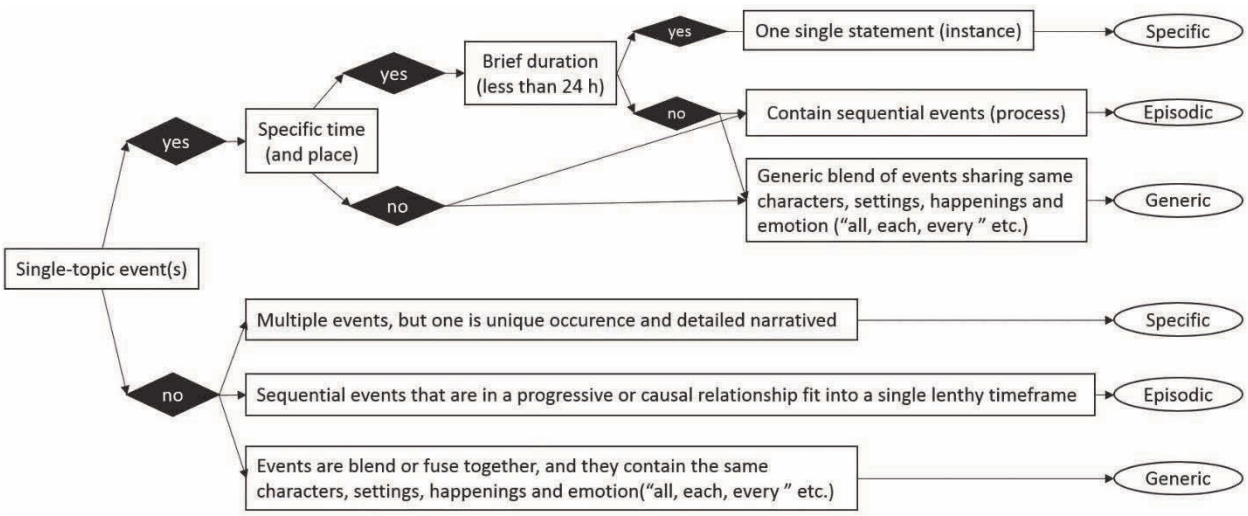

Figure. The flow chart of coding on the narrative specificity

Variable 2: Grief-related content of Memory Narrative

The memories about the deceased involve bereavement experiences, grief-related experiences about the deceased, and memories of the deceased person that were neither death- nor grief-related. This category consists of two types (Maccallum & Bryant, 2008):

- **Narratives related to the deceased**: this category of narratives concerns with the deceased person. It involves the bereavement experiences and grief symptoms caused by the loss of the child. Furthermore, the participants recounted their life events in relation to the child before (s)he died.
- **Narratives unrelated to the deceased**: narratives concerns with grievers themselves or their interaction with others except the dead child. In our study, this category is applicable if participants talked about another deceased person (not the lost child), such as bereaved parents or partner.

In the coding system, we further clarify the "deceased-related narratives" into two subtypes: (1) narratives about "loss" and (2) narratives about "person" without involving grief (Maccallum & Bryant, 2010).

1. Narratives about "Loss"

Score 1

The "loss" category includes memories of events that are associated with the individual's death or memories relating to an aspect of the grief experiences.

This category involves following three conditions (Boelen *et al.*, 2010a):

(1) Memories referring to the moments when the child died;

(2) Narratives surrounding the actual death (e.g., "*I was somewhat selfish when I wanted to be alone with my husband immediately after he died*");

(3) Memories that occur after the death and include a reference to the loss or grief (e.g., "*I felt lonely at a friend's birthday party I went to two weeks after my husband died*"). Grief experiences involve one or several aspects in the following:

- Yearning (to recall bittersweet memories of the deceased person and other related experiences), for example, "*sometimes the pictures how he suffered in the pain of disease came up into my mind. I felt so distress about his hard life. Sometimes, all the good things he did for me also make me sad*."

- Emotional reactions such as sad, guilty, angry, regretful, numb, shame, self-blame that are associated with the bereavement. For example, "*When I recall my child, I feel very sad. I am always agitated and desire to see him again. I keep crying*."
- Intrusion of traumatic memories.

2. "Person" Narratives

Score 2

The "person" category refers to memories on the deceased, which were neither death- nor grief-related. For example, "*The day when my son attended college attended examination, I told him 'I will send to you to school', he rejected. But I followed quietly until his school*."

3. Narratives about "others"

Score 3

All remaining memories are coded as "other" if they do not relate to the deceased. For example, the participants recounted some events about themselves ("*After the surgery, the moment I opened the eyes, I felt very fear. I could hear all the cries around me*") or with another person ("*I felt very happy at the day when I got married with my late husband*").

Part II Self & Value Defining Memory Task (SVDMT)

Coding Table for Self & Value Defining Memory Task

Dimensions#	**Variables**		**Type**		**Scoring Number**
Structure	Specificity		Specific memory narrative		1
			General memory narrative		2
Content	Grief-related content		Narratives related to the deceased	Loss	1
				Deceased involved	2
			Narratives unrelated to the deceased	Others	3
	Value orientation		Support		1
			Opposite		2
			Other		3
Meaning making	Level	Unintegrated narratives	Absent meaning making		0
		Integrated narratives	Lesson learning		1
			Gaining insight		2
	Valence	Negative meaning	Without negative meaning		0
			With negative meaning		1
		Positive meaning	Without positive meaning		0
			With positive meaning		1
	Content	Self	With “self” content in meaning		1
			Without “self” content in meaning		0
		Others-related	With “others” content in meaning		1
			Without “others” content in meaning		0
		Life orientation	With “life” content in meaning		1
			Without “life” content in meaning		0
		Spiritual/religious	With “spirit” content in meaning		1
			Without “spirit” content in meaning		0
Affect	Valence		Rated by SAM test during interview		
	Arousal				

Dimension system is modified from Blagov and Singer (2004)

Variable 1: Specificity of Memory Narrative

Please refer to Autobiographical Memory Task in Part I.

Variable 2: Grief-related Content of Memory Narrative

The "narratives related to the deceased" consists of narratives about "loss" and "deceased involved". The approach to code narratives regarding to "loss" is in accord with AMT. Please notice that the coding narrative about "the deceased involved" is different.

1. Narratives about "Loss"

The 'loss' category includes memories of events that are associated with the individual's death or memories relating to grief experiences.

This coding involves following three categories (Boelen et al., 2010a):

- Memories referring to the moments with the lost person;
- Narratives surrounding the actual death (e.g., "*I was somewhat selfish when I wanted to be alone with my husband immediately after he died*");
- Memories after the death that included a reference to the loss or grief (e.g., "*I felt lonely at a friend's birthday party I went to two weeks after my husband died*").

2. Memory narratives about "the deceased involved"

This category refers to memories involving the deceased person that are neither death nor grief-related. However, it consists of two conditions that are different from the AMT:

- The main content or topic focuses on the deceased person, but are neither death nor grief-related (e.g., "*I think my son is a person with great benevolence. After the great earthquake in Sichuan, he came back home and told me that he registered as a volunteer for blood donation*".)
- Although the main part of the narratives does not concern with the death or bereavement experiences of child, but to some extent the deceased person is involved in the recounted events or the participant associated the event with the deceased by giving specific comments.

3. Memory narratives about "others"

All remaining memories were coded as ''other''.

Variable 3: Value Orientations

The theory of human values (Schwartz, 1994) defines values as guiding principles to the functioning of people or society across different contexts. Schwartz and Bilsky (1990) proposed a nomenclature of ten value dimensions derived from universal requirements of the human condition and validated in cross-cultural research projects. Each value dimension is defined in terms of its central goal (i.e. the desired end state to which it is directed).

Joining with social structure, history, demography and ecology, values orientation is constantly developing. Conservation and self-transcendence can be regarded as traditional values, whereas openness to change and self-enhancement reflect modern values (Maercker *et al.*, 2009). Traditional values mostly represent the value orientations of traditional or less-developed societies and countries with long-term history, whereas modern values correspond with and evolve alongside the achievements of modern developed countries with post-industrial economies (Burri & Maercker, 2014). Traditional values stress collectivism, submissive self-restriction, preservation of traditional practices, protection, and stability. Modern values represent motivations to pursue one's own success and dominance over others or gratification for oneself, and stress flexibility (Maercker *et al.*, 2009).

Our study groups self-direction, stimulation and hedonism into modern values, while conformity, tradition and benevolence are categorized into traditional values (Burri & Maercker, 2014). A description of the six individual value orientations can be found in the following table (Hinz *et al.*, 2005).

Value	**Description**
Modern	
Stimulation	Excitement, novelty, and challenge in life. (He/she looks for adventures and likes to take risks. He/she wants to have an exciting life.)
Self-direction	Independence of thought and action: choosing, creating and exploring. (He/she thinks it is important to be interested in things. He/she is curious and tries to understand everything.)
Hedonism	Pleasure or sensuous gratification. (He/she really wants to enjoy life. Having a good time is very important to him/her.)

Traditional

Conformity	Restraint of actions that may harm others. (He/she believes that people should do what they are told. He/she thinks people should follow rules at all times, even when no one is watching.)
Tradition	Respect and commitment to cultural customs and ideas. (He/she thinks it is important to do things the way he/she learned from his family. He/she wants to follow their customs and traditions.)
Benevolence	Enhancing the welfare of people to whom one is close. (He/she always wants to help the people who are close to him/her. It is very important to him/her to care for the people he/she knows and likes.)

The content for value orientations is coded as following.

Please note: as different participants may have their own perspectives on the definition and criterions of value orientation, coder should code the "support" or "opposite" based on the definitions in above table, not according to participants' own opinions. For example, "*If I do a good job in my work, I will be very happy. This is also a kind of hedonism. Actually, what I learned in my major is mainly different from what I'm doing. At the beginning of this job, I endeavored to study, very hard but deeply. After I came back from work in the evening, I continued to study even until midnight. It was not too long that I handled nearly all my work. At that time, my chefs appreciated me a lot and no one could do better than me. Actually, this is also hedonism, to enjoy such a happy processing.*" In this narrative, the participant had her own understanding about "hedonism". However, her definition is not consistent with the above definition shown in table "*Hedonism is to pursue pleasure or sensuous gratification. He/she really wants to enjoy life. Having a good time is very important to him/her*." Therefore, this narrative should be coded as "opposite" or "other".

1. Memory narratives "support" the value.

The content of memory narratives provides an evidence that (1) participant has beliefs in related to the topic values, (2) the value refers to their desirable goals or objectives that motivate action, (3) their behaviors, habitations or decisions follow or are prioritized by the standards or criteria of this value orientation. These events can be either specific actions and situations, or general narratives.

2. Memory narratives are "opposite" to the value

(1) Participants claimed that they had an opposite value and recounted some events to clarify his or her own characteristic, beliefs or values.

(2) Participants did not clarify their own side. However, their narrated events are opposite to the value descriptions in the above table (e.g. opposite to Hedonism: "*I'm content with my life. I have something to eat, enough clothes to wear. I think this is already some kind of enjoying life*"). The opposite relationship should be clear.

3. Other

(1) "**Unrelated**": The memory narratives are unrelated to the value. For example, stimulation refers to an exciting lifestyle that tends to challenges and risks. However, the narrative that the experience of losing a child is a stimulation for them is not consistent with the definition. Hence, such narratives should be coded "other".

(2) "**Unclear**": some narratives are confusing or unclear that participants did not clearly state his/her value orientation or did not provide some events or examples such that coder cannot make decision.

- **Intention, attitude or tendency without narratives about real experiences or actions**. For example "*My son hadn't gone outside, gone another cities. He always stayed in Beijing. My son had not travel around due to the poor family condition. It was impossible to take my child to travel around. The only place where he had been is Beidai River, together with my colleagues. So my son had no experiences to travel and enjoy life. That's the reason why I now try utmost to go outside to travel and see just for him.*"
- The narratives are too ambiguous to judge whether they are support or opposite.

(3) **Self-contradictory or incongruous**:

- **Self-contradictory between events and personal statement/attitude.** In the interview, the participants might criticize their previous behavior or give a negative evaluation to the event. For example, "*I regret that I didn't insist on my own opinion and bowed to authority. I complied with the policy*". Despite of the criticism and regrets, the participant still agree that these behaviors correspond to *conformity*. Therefore, the narratives should be considered in the context whether the main content or core idea supports the topic-cue of value orientation.

- **Incongruous behaviors:** "*I hardly conform others. In my work, I have never conformed anyone, even my chef asked me to do something, I would think why it's me before I did. If it was unreasonable, I would not do that….But for her, because there are only us at home, I don't want to annoy her. It's always I who make big decisions in my family, but for minor things in daily life, I would not like to make her worried, so listen to her and conform to her. As she has hypertension, I should tolerant more*." This example describes different behaviors in two situations.

Variable 4: Meaning-making

Meaning is what the reporter has gleaned, learned, or understand from the event. According to Thorne *et al.* (2004), meaning making for life events can be categorized into lesson learning and gaining insight.

In our study, narratives that were used for meaning-making coding originated from two parts: (1) participants' comments or summaries at the beginning or at the end of recounting the memory events; (2) After recounting the memories, the participants were encouraged to give comments initiated by following questions "How do you evaluate this event right now? Or what does it mean to you and your life?"

1. "Level" of meaning making

The level of meaning making encompasses non-integrative narratives, lesson learning and gaining insight.

1.1 Unintegrated narratives

Score for meaning level, valence and content: 0

The coding of "non-integrative narratives" refers to the coding manual "*Classification System and Scoring Manual for Self-defining Autobiographical Memories*" from Singer and Blagov (2000).

1.1.1 Two **Subtypes**

1.1.1.1 Unintegrated narratives of Type 1 (Pure narratives of events without extension):

The narrative describes events within the timeframe of the specific event, episode, or blended series of events. There is no discussion of any broader context, category of experience, or importance of the events in the memory. **If the emotions, thoughts, or attributes of the**

participants in the memory are discussed, these statements are located in the timeframe of the memory. For example, "*When I fell from the tree, I was so scared that I had broken my leg. I thought about what would happen if I could never walk or run again*."

1.1.1.2 Unintegrated narratives of Type 2 (Categorization by Emotion, Impact, Context or Attribute):

The narrative goes beyond the location of the memory in a particular time period to include information about the category of emotion, impact, context, or attribute of the remembered experience. These statements identify the memory as being an example:

- **Type of emotion** ("*This is one of my happiest memories*", "*I feel very guilty*", "*I feel no guilt, I'm this kind of person* "),
- **Type of impact** ("*This is one of my most important memories*", but why it's important wasn't clarified),
- **Type of context** ("*I was part of the debate team in my junior year of high school*")
- **Type of attribute**: the evaluations are expressions of right or wrong, good or bad, favor or disfavor toward a person, place, thing or event. ("*I was always an angry child*";" *I think that it is worth to do these*", "*I should be a traditional person*").

Beyond locating the memory in this particular memory bin, **the narrative makes no interpretative statement about the larger significance or meaning of the memory in general or to the person's life.** That is, the narrative does not include any statement about what the individual has learned from the experience described, nor does the individual specifies in what particular way the experience has influenced his or her life.

Individual may also make generalizations about time in the memory, such as, "This was my first experience with death" or "I recall my first day of school." Although these generalizations or categorizations are not simple time stamps, they are also not integrated processing unless they contain additional meaning statements that express a meaning or lesson learned from these "first" events. Without such statements, these "first" memories should still be scored as unintegrated.

1.2 Integrated Memories

Integrated memories step back from narrative events and generalizations described in the memory to make an additional statement about the specific significance or meaning of the memory to the individual. A meaningful statement must extend beyond simple pronouncements

that the memory is "important" or "the most painful" or "one that I will never forget," but also include **an indication of why the memory holds this quality of importance, emotion or vividness for the individual.**

Based on theories of meaning making and post-traumatic growth, we propose that the meaning making has at least three components:

- Level: lessons learning vs. insights gaining (Thorne *et al.*, 2004)
- Valence: negative vs. positive meaning (Cox & McAdams, 2014)
- Content: Meaning tied to self vs. related to others vs. life orientation vs. spiritual/religious (Ho *et al.*, 2004)

Attention! The coding of "level", "valence" and "content" are only for integrated narratives. When the evaluations are unintegrated narratives, please code the "level", "valence" and "content" as 0.

1.2.1 "Level" of meaning making

This part refers to "*Manual for Coding Meaning Making in Self-Defining Memories*" (McLean & Thorne, 2001)

1.2.1.1 Lesson learning

Score for meaning level: 1

Lesson learning is to learn a specific lesson from an event that can direct future behaviors in similar situations. Lessons are fairly concrete and mainly include behaviors directing and problem solving. Lesson learning can be found in the following narratives:

(1) During evaluating, participants summarized lesson or experiences that can be applied in similar situations or events.

(2) Participants applied their experiences to direct future behavior or deal with problems.

What is the difference between lesson learning and expression of emotion or attitude in the unintegrated narratives? The expression of emotion ("*I feel guilty*") and expression of attitude ("*I think I'm right to be traditional*", "*It's worthy that I have done this way*", "*In the future, I will do it like this and say this again*") only concentrate on a specific event or give comments on the narratives. However, lesson learning means to apply these attitudes or lessons from one situation to others, especially to future situations.

1.2.1.2 Gaining insight

Score for meaning level: 2

Gaining insight is not restricted to specific situations of original or similar narratives. Instead, it means to reflect upon the larger implications of the event for one's construal of self, of another person, or one's relationship with someone. There is often some kind of transformation in one's understanding of oneself or one's relationships with others. **Comparing with lesson learning, insights are usually more abstract and involve self-narrative and/or belief system (including social beliefs, life beliefs and spiritual beliefs)**.

For example, an event in which a son throws eggs at his mom. If the son comments that he learned never to throw eggs at his mom again, he claims to have learned a lesson. Furthermore, if the son commented that he realized that he had an anger management problem, his realization counts as gaining insight because it extends beyond eggs and beyond mom.

According to the level of meaning making, gaining insight is higher or deeper than lesson learning. When one narrative contains both sides of content, please code it as "gaining insight".

Questions about "Level" of meaning making	
1. Does the evaluation only focus on the recounted event itself or locate in the timeframe of the narrated memory?	Unintegrated narratives
2. Do the comments express the participant's emotion or attitudes toward to person, thing or events, instead of lesson or meaning?	
3. Did the participant get lessons from the recounted event: behavioral directing or problem solving?	Lesson learning
4. Had the participant connected their previous experiences or lessons to a similar situation in the future?	
5. Do the general meanings involve self-narratives?	Insight gaining
6. Do the general meanings involve their belief system (social, life and spiritual beliefs)?	

2. "Valence" of meaning making

The valence of meaning making has two dimensions instead of one dimension with two poplars: negative meaning and positive meaning. Therefore, each comment for one recounted events should be coded as negative and positive meaning respectively. **Notably, the coding of**

valence is not identified by the emotion expressed by participants during narrative or evaluation. Instead, coder should judge whether the content is positive meaning or negative meaning.

2.2.1 Negative meaning

"0" for narratives without negative meanings;

"1" for narratives with one or more following negative meanings: participants made statements in a negative direction that include (1) catastrophic misinterpretations of reactions, (2) negative lessons learned, or (3) negative evaluations or/and beliefs about self, interpersonal relationships, expectations of the future, life meanings and so on. These lessons may be statements about life in general or lessons learned regarding a particular person, group or institution.

The negative statements can follow narratives of some negative experiences. In addition, it can be a contamination where good things go bad, or/and stay bad.

2.2.1 Positive meaning

"0" for narratives without positive meanings;

"1" for narratives with positive meanings: (1) participants gave positive comments on the recounted event; (2) participants had a positive or optimistic attitude to their reactions or the development of events; (3) participants gained a positive or useful lesson from the event; (4) participants gave positive comments on or expressed optimistic attitudes to themselves, relationship, future life and even life value.

The statements for memories go in a positive direction, including positive comments for positive experiences and redemption (negative experiences turning out positively).

3. "Content" of meaning making

As some participants tended to make meaning from multiple perspectives (e.g. making meanings about both self-concept and life value), coders process this coding for four contents respectively: code "1" when meaning involved this content, or code "0" for meaning without this content

2.3.1 "Meaning tied to the self":

"Meaning tied to the self" encompasses memories that include statements about lessons or understandings that are explicitly connected to the individual self and sense of identity. The change in self includes:

- A willingness to express emotions,
- Changes in the acceptance of how things work out in individual life,
- Strength or development in personal skills, capabilities, personality etc.
- Developing new interests
- Find new approaches or opportunities to improve or change oneself ("*these events help me to understand this society and will help me to become a good member of this system*").

It is not enough that the narrative includes statements about characteristics of the self (e.g., "*I am funny*," or "*I get sad at sunsets*"). The memory narrative must include a statement about what this attribute means to the individual or how the memory exemplifies a change in this attribute. For example, "*Ever since I broke up with my girlfriend, I get sad at sunsets. We were watching one when she told me it was over. Now when I think of a sunset, I realize that I can't always be sure of another person.*"

2.3.2 Integrated narratives about "Relating to others"

The evaluation of the events emphasizes an understanding of others and changes in interpersonal relationship. These changes encompass:

- Real changes in interpersonal relationships
- Lesson learning, beliefs or values about what an interpersonal relationship is, how to keep, change or deal with relationship (e.g. "*There is no difference in human nature. People should respect each other and be polite*")
- Statements about the importance and significance of one relationship in the individual's life. This statement would again need to expand beyond a mere statement of the importance of the relationship (e.g., "*She was my first love*" or "*She is my favorite aunt*"). It explains the meaning or ongoing significance of the relationship in the person's life (e.g., "*I always turn to her when I am down*," or "*She continues to serve as a role model to me years later*").
- A deeper understanding about others' life story, characters, attitudes etc. ("*Despite of the short life, my son had a colorful life. He has such good parents like us. He wasn't worried about anything in his life*.")

2.3.3 Integrated narratives about "life orientation"

Life orientation refers to people's changes in "lesson learning", beliefs, and values of current, future life or personal entire life:

- To learn life experiences and lessons ("*Every stimulation should have a limitation. If the stimulation is under my capabilities, I will enjoy it and feel excited*.")
- Life priorities ("*To take good care of my wife and enjoy every moments with her is most important in our later years*")
- Beliefs about the changeability of things in life (" *I still have a confidence that I will try to change the current condition and cope with negative emotions*")

2.3.4 Integrated narratives about "Spiritual/religious"

Spiritual/religious meanings include changes in spiritual life and religious beliefs. ("*After these experiences, I strengthened my confidences in the god*", "*Everyone has his own fate. No matter who you are, what your job is, eventually you must comply with your fate*.")

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Sep 2013 - Present **Doctoral Program of Psychology,** Psychology
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Sep 2010 - June 2013 **Bachelor of Science**, Biology science
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Research experiences

May 2016 - present **Project leader**

Community-based group art therapy for Chinese parents who lost their only child

- Collaborator: Dr. Li He, Beijing Union University
- Funding: Social Science Foundation of Beijing, China (¥ 80,000)

June 2014 - Present **Project leader**

Grief, autobiographical memory and personal value orientation: a cross-cultural study in Chinese and Swiss bereaved parents

- Collaborator: Prof. Xiaoming Jia, Beijing Institute of Technology
- Supervision on three master theses

Jan 2012 - June 2015 **Research Assistant**

The genetic and neural mechanisms of positive and negative personalities

- Founding: Natural Science Foundation of China, Youth Scientist Found
- Mentor: Prof. Qi Dong and Dr. Chunhui Chen, Beijing normal university

Feb 2009 - June 2010 **Research Assistant**

Personality characteristics and psychological intervention on female nursing Students in the occupational secondary school

- Founding: Science Project of Xindu District, Chengdu, Sichuan
- Mentor: Prof. Zhi Chen, Sichuan university

Publications & Working papers

Xiu, **D**., Maercker, A., Yang, Y. & Jia, X. (Revised and resubmitted). Prolonged grief, autobiographical memory and their interactions with personal value orientation in China and Switzerland. *Journal of Cross-Cultural Psychology*. (*IF* = 2.24)

Xiu, **D**., Maercker, A., Killikelly, C., Yang, Y. & Jia, X. (Under review). Personal value orientation and meaning-making narration in grieving parents: a cross-cultural study in China and Switzerland. *Clinical Psychology* & *Psychotherapy*. (*IF* = 2.96)

Xiu, D., He, L., Maercker, A. (Under review). Prolonged grief disorder and positive affect improved by community-based Chinese brush painting group in bereaved parents: a pilot study. *Death Studies*. (*IF* = 1.31)

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Heim, E., Scholten, S., Maercker, A., **Xiu, D**., Cai, D., Gao, Z.H., Lu, S., Sang, Z.Q., Wei, J., Kochetkov, Y. & Margraf, J. (in press) Students' value orientations in contemporary China: Analysis of measurement invariance and latent mean differences in comparison with students from Germany and Russia. *Journal of Cross-Cultural Psychology*. (*IF* = 2.24)

Xiu, D. & Xue, H., (2013). [Searching the trace of learning and memory in the brain]. *Bulletin of Biology*, 08. (*Chinese review*)

Conference

Xiu, D., Maercker, A. (2017, February). Features of prolonged grief symptoms in Chinese and Swiss bereaved parents. Oral presentation at 19th *Deutschsprachige Gesellschaft für Psychotraumatologie*, Zurich, Switzerland

Xiu, D., Maercker, A. (2016, June). Prolonged grief and autobiographical memory: link to value orientation in China and Switzerland. Poster presented at *Travelling in time: The construction of past and future events across domains*, Aarhus, Denmark.

Xiu, D., Maercker, A. (2015, September). Losing the only child! The self-value defining memory in Chinese bereaved parents. Poster presented at *The Future of Psychology-SSP/SGP Conference 2015*, Geneva, Switzerland.

Xiu, D., Maercker, A. (2015, June). Losing your only child! Combing value orientations and grief symptoms to predict autobiographical memories' disruption in Chinese bereaved parents. Oral presentation at the *XIV Conference of European Society for Traumatic Stress Studies*, Vilnius, Lithuania.

Honors & Rewards

2016 Travel grant (University of Zurich) for mentorship at University of Memphis

2013 National study aboard scholarship from Chinese Scholarship Council

2011 "Advanced Individual in Social Work" in Beijing Normal University

2010 "Outstanding Graduate" of Sichuan University

2008 "Outstanding Student" of Sichuan University

2007 The First Prize of "Individual Scholarship" of Sichuan University